Psychological interventions for acute pain after open heart surgery

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Psychological interventions for acute pain after open heart surgery (Review)

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TABLE OF CONTENTS

[Intervention Review]

Psychological interventions for acute pain after open heart surgery

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ABSTRACT

Background

This is an update of a Cochrane review previously published in 2014. Acute postoperative pain is one of the most disturbing complaints in open heart surgery, and is associated with a risk of negative consequences. Several trials investigated the effects of psychological interventions to reduce acute postoperative pain and improve the course of physical and psychological recovery of participants undergoing open heart surgery.

Objectives

To compare the efficacy of psychological interventions as an adjunct to standard care versus standard care alone or standard care plus attention control in adults undergoing open heart surgery for pain, pain medication, psychological distress, mobility, and time to extubation.

Search methods

For this update, we searched the Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, Embase, Web of Science, and PsycINFO for eligible studies up to February 2017. We used the 'related articles' and 'cited by' options of eligible studies to identify additional relevant studies. We checked lists of references of relevant articles and previous reviews. We searched the ProQuest Dissertations and Theses Full Text Database, ClinicalTrials and the WHO International Clinical Trials Registry Platform to identify any unpublished material or ongoing trials. We also contacted the authors of primary studies to identify any unpublished material. In addition, we wrote to all leading heart centres in Germany, Switzerland, and Austria to check whether they were aware of any ongoing trials.

Selection criteria

Randomised controlled trials comparing psychological interventions as an adjunct to standard care versus standard care alone or standard care plus attention in adults undergoing open heart surgery.

Data collection and analysis

Two review authors (SZ and SK) independently assessed trials for eligibility, estimated the risk of bias and extracted all data. We calculated effect sizes for each comparison (Hedges' g) and meta-analysed data using a random-effects model. We assessed the evidence using GRADE and created 'Summary of findings' tables.

Main results

We added six studies to this update. Overall, we included 23 studies (2669 participants).

For the majority of outcomes (two-thirds), we could not perform a meta-analysis since outcomes were not measured, or data were provided by one trial only.

No study reported data on the number of participants with pain intensity reduction of at least 50% from baseline. Only one study reported data on the number of participants below 30/100 mm on the Visual Analogue Scale (VAS) in pain intensity (very low-quality evidence). Psychological interventions did not reduce pain intensity in the short-term interval (g 0.39, 95% CI -0.18 to 0.96, 2 studies, 104 participants, low-quality evidence), medium-term interval (g -0.02, 95% CI -0.24 to 0.20, 4 studies, 413 participants, moderate-quality evidence) or in the long-term interval (g 0.05, 95% CI -0.20 to 0.30, 2 studies, 200 participants, moderate-quality evidence).

No study reported data on median time to re-medication or on number of participants re-medicated. Only two studies provided data on postoperative analgesic use in the short-term interval, showing that psychological interventions did not reduce the use of analgesic medication (g 1.18, 95% CI -2.03 to 4.39, 2 studies, 104 participants, low-quality evidence). Studies revealed that psychological interventions reduced mental distress in the medium-term (g 0.37, 95% CI 0.13 to 0.60, 13 studies, 1388 participants, moderate-quality evidence) and likewise in the long-term interval (g 0.32, 95% CI 0.10 to 0.53, 14 studies, 1586 participants, moderate-quality evidence). Psychological interventions did not improve mobility in the medium-term interval (g 0.23, 95% CI -0.22 to 0.67, 3 studies, 444 participants, low-quality evidence), nor in the long-term interval (g 0.09, 95% CI -0.10 to 0.28, 4 studies, 458 participants, moderate-quality evidence). Only two studies reported data on time to extubation, indicating that psychological interventions reduced the time to extubation (g 0.56, 95% CI 0.08 to 1.03, 2 studies, 154 participants, low-quality evidence).

Overall, the very low to moderate quality of the body of evidence on the efficacy of psychological interventions for acute pain after open heart surgery cannot be regarded as sufficient to draw robust conclusions.

Most 'Risk of bias' assessments were low or unclear. We judged selection bias (random sequence generation) and attrition bias to be mostly low risk for included studies. However, we judged the risk of selection bias (allocation concealment), performance bias, detection bias and reporting bias to be mostly unclear.

Authors' conclusions

In line with the conclusions of our previous review, there is a lack of evidence to support or refute psychological interventions in order to reduce postoperative pain in participants undergoing open heart surgery. We found moderate-quality evidence that psychological interventions reduced mental distress in participants undergoing open heart surgery. Given the small numbers of studies, it is not possible to draw robust conclusions on the efficacy of psychological interventions on outcomes such as analgesic use, mobility, and time to extubation respectively on adverse events or harms of psychological interventions.

PLAIN LANGUAGE SUMMARY

Psychological treatments to reduce pain in people undergoing open heart surgery

Background

Acute postoperative pain is one of the most disturbing complaints after open heart surgery. It is related to impaired wound healing, chronic pain, or depression. Psychological treatment is designed to improve participant' knowledge and to alter surgery-related mental distress, negative beliefs and noncompliance. It aims to reduce pain and anxiety, and to improve the postoperative recovery after open heart surgery.

This is an update of a review previously published in 2014 investigating whether psychological treatment could successfully reduce acute postoperative pain and improve the course of physical and psychological recovery of people undergoing open heart surgery.

Study characteristics

We found 23 studies, including a total of 2669 participants, which reported effects of psychological treatment compared to a control group without psychological treatment on pain intensity, use of pain medication, mental distress, mobility, or time to extubation after surgery.

Key findings and quality of evidence

We rated the quality of the evidence from studies using four levels: very low, low, moderate, or high. Very low-quality evidence means that we are very uncertain about the results. High-quality evidence means that we are very confident in the results.

We do not know if psychological treatment reduces pain intensity, enhances mobility, or decreases intubation time after open heart surgery. This is because there were not enough data to answer some parts of our review question, because there were problems with the design of some studies, or because results were conflicting. We only found very low to moderate-quality evidence for these outcomes.

We found moderate-quality evidence that psychological treatment could reduce mental distress. This means that we are moderately certain about the results because there were psychological treatments that clearly reduced distress whereas others did not.

The evidence in our review is current to February 2017.

SUMMARY OF FINDINGS FOR THE MAIN COMPARISON [Explanation]

Psychological interventions compared with control conditions for acute pain after open heart surgery (short-term)

Patient or population: adults undergoing open heart surgery
Settings: inpatient, surgical care
Intervention: psychological intervention
Comparison: control condition (either standard care or attention)
Short-term: outcome measured within the first 48 hours postoperatively

Outcomes	Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
Number of participants with self-reported pain intensity reduction of at least 50% from baseline	-	-	-	No data available
Number of participants below 30/100 mm on the visual analogue scale (VAS) in self-reported postoperative pain intensity	RR = 1.20 (0.68 to 2.12) ; NNTB = 14	73 participants (1 study)	⊕◯◯◯ **very low** [a,b,c]	
Participant-reported postoperative pain intensity measured on continuous scales measured with a range of scales[1]	g 0.39 (-0.18 to 0.96)	104 participants (2 studies)	⊕⊕◯◯ **low** [a,b]	
Analgesic use measured via PCA	g 1.18 (-2.03 to 4.39)	104 participants (2 studies)	⊕⊕◯◯ **low** [a,b]	
Mental distress measured with a range of scales[1]	g 0.00 (-0.44 to 0.44)	74 participants (1 study)	⊕⊕◯◯ **low** [a,b]	
Mobility measured with a range of scales[1]	-	-	-	No data available
Time to extubation	g 0.56 (0.08 to 1.03)	154 participants (2 studies)	⊕⊕◯◯ **low** [a,b]	

CI: 95% Confidence interval;
g: Hedge´ s g: a positive effect size indicates a reduction of pain intensity and mental distress, as well as an enhancement of mobility
RR: Risk Ratio
NNTB: Number needed to treat for one additional beneficial outcome

[1]We listed the range of scales and additional information in the Characteristics of included studies

GRADE Working Group grades of evidence
High quality: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate quality: we are moderately confident in the effect estimate; the true effect is likely to be close to the estimate of effect, but there is a possibility that it is substantially different.
Low quality: our confidence in the effect estimate is limited; the true effect may be substantially different from the estimate of the effect.
Very low quality: we have very little confidence in the effect estimate; the true effect is likely to be substantially different from the estimate of effect

[a] Downgraded once for imprecision due to wide confidence intervals
[b] Downgraded once for indirectness due to indirect evidence for psychological interventions in general (e.g. if in included studies only one specific intervention program was implemented, than evidence on the effects of psychological interventions outside these specific program may be indirect).
[c] Downgraded once for inconsistency due to heterogeneity $I^2 > 50\%$

BACKGROUND

Description of the condition

Open heart surgery is one of the most frequently conducted major surgical procedures in general hospitals. About 397,000 coronary artery bypass graft surgeries (CABG) and 106,000 valve surgeries were performed in the United States in 2010 (Mozaffarian 2015). In Germany, about 52,000 CABG procedures and about 32,000 valve surgeries were registered in 2015 (Beckmann 2016).

The most disturbing complaint in open heart surgery is acute pain, which is still a severe and under-treated problem (Cogan 2010; Sattari 2013). Acute pain is the most common symptom experienced by participants after open heart surgery, and pain relief is often perceived as inadequate during the hospital recovery period (Aslan 2009; Valdix 1995; Choiniere 2014).

The worst pain is experienced during the first 48 hours, which are spent in the intensive care unit (ICU) (Choiniere 2014). Following intensive care, the presence of chest tubes and their removal, endotracheal tube suctioning, vomiting, turning, breathing and change of dressing are also severely painful experiences (Aslan 2009; Gelinas 2007; Ghanbari 2016; Pozas 2014). Pain symptoms after open heart surgery can be multiple, are described as burning or throbbing, located mainly in the thorax at the site of sternal incision, and may be of visceral, musculoskeletal or neurogenic origin (Cogan 2010; Gelinas 2007).

Acute postoperative pain has negative consequences for health. It has been shown that people undergoing cardiac surgery with severe levels of acute postoperative pain have a 3.5 times higher risk of suffering from chronic pain after cardiac surgery (Cogan 2010). Evidence also demonstrates that postoperative pain is a significant predictor of postoperative wound healing (McGuire 2006), a key variable of postoperative recovery in open heart surgery. Moreover, poor pain management may lead to depression (Cogan 2010) in addition to negative pulmonary, cardiac, gastrointestinal and musculoskeletal effects. There is clear evidence that post-CABG depression predicts decreased health-related quality of life, reduced activity levels, chronic chest pain, poorer cardiac symptom relief, as well as increased rates of rehospitalisation and mortality independent of cardiac status, somatic comorbidity or the extent of surgery (Barth 2004; Blumenthal 2003; Burg 2003; Connerney 2001; Doering 2005; Foss-Nieradko 2012; Goyal 2005; Mallik 2005; Nunes 2013; Oxlad 2006; Pignay-Demaria 2003; Watkins 2013). However, to our knowledge, there are no empirical stud-

ies which test the pathways between acute postoperative pain after CABG, post-CABG depression and worse surgical long-term outcomes in one model. Thus, the underlying mechanisms as yet remain unclear.

It is not surprising that acute postoperative pain after open heart surgery is mainly determined by surgery-related factors (e.g. duration and the location of surgery; Sommer 2008). However, given the association between anxiety, depression and postoperative outcomes such as mortality, wound healing and complications (Ai 2006; Connerney 2001; Foss-Nieradko 2012; Ho 2005; Korbmacher 2013; Mavros 2011; Perski 1998; Stengrevics 1996; Szekely 2007; Tully 2008; Watkins 2013), research has investigated the question of whether the psychological condition of participants influences postoperative pain levels after open heart surgery.

Consequently, attempts have been made to determine if psychological interventions can successfully reduce acute postoperative pain and improve the course of physical and psychological recovery of people undergoing open heart surgery.

Description of the intervention

This review focused on psychological interventions, defined as those based on established psychological theories of behaviour and behaviour change, with identifiable components of treatment, specifically designed to alter surgery-related mental distress, negative beliefs and noncompliance in order to improve the postoperative recovery after open heart surgery. Psychological interventions in the context of cardiac surgery are conducted as an adjunct to standard surgical care within the time of hospitalisation by physicians, psychologists, nurses, or other trained treatment providers (e.g. former patient models), including personal communication, printed information (leaflets), or audio or video recordings (Tigges-Limmer 2011). The following types of psychological intervention are common in the context of cardiac surgery: Psychoeducational interventions, which are defined as the provision of information about pre-, intra- and postoperative medical procedures with a special focus on associated psychological responses, sensations, and emotions. These interventions also involve behavioural instructions about appropriate ways people can adhere to medical advice to support their recovery (Devine 1992). Cognitive-behavioural methods, comprising methods of cognitive restructuring, reframing and reappraisal based on the evaluation of participants' specific needs according to their individual situation (Powell 2016).

Relaxation techniques are described as teaching or instructing participants systematically in, for example, progressive muscle relaxation, relaxing breathing techniques, (self) hypnosis, guided imagery, or autogenic training (Elkins 2015; Green 2005; Michie 2008).

These interventions can partially overlap with other kinds of interventions, such as those that focus on psychological preparation of adults undergoing surgery under general anaesthesia, which is covered by a Cochrane review (Powell 2016). Moreover, the analgesic effects of clinical hypnosis is the focus of a review also considering the context of medical procedures (Kendrick 2016).

How the intervention might work

There is no evidence-based model for how psychological interventions in the context of cardiac surgery might reduce postoperative pain. However, it is reasonable to assume that psychological interventions might reduce pain by the alteration of surgery-related mental distress, negative beliefs and non-compliance, as well as by their interactions with each other.

Psychological interventions focus on the reduction of anxiety, depression, and mental distress, which in consequence might affect pain. There is evidence that negative emotions decrease the pain perception threshold (Rainville 2005). In studies on non-cardiac surgery participants, levels of anxiety and depression predicted postoperative pain (Arpino 2004; Granot 2005; Johnston 1988; Linn 1988; Mathews 1981; Munafo 2001; Reddi 2016; Theunissen 2012). In addition, in studies on people undergoing cardiac surgery, it was demonstrated that psychosocial variables such as anxiety, depression, optimism, and perceived social support are also associated with postoperative pain (Con 1999; Jette 1996; Karlsson 1999; Morone 2010; Ronaldson 2014).

Psychological interventions also deal with noncompliance to alter participants' behaviour. People undergoing open heart surgery are less likely to remain passive in their course of recovery if they are informed about the importance of compliance with early postoperative mobilisation and thereby might have a decreased rate of postoperative complications and lower levels of postoperative pain.

Cognitive interventions focus primarily on changing negative or dysfunctional beliefs and attitudes towards surgery into more positive and helpful ones. For example, a positive and confident attitude towards surgery and the recovery period is associated with reduced anxiety, facilitates postoperative behavioural activation, and thereby might decrease pain levels (Heye 2002; Ronaldson 2014; Varaei 2017).

Why it is important to do this review

Our previously published Cochrane review (Koranyi 2014) showed promising low-quality of evidence for reducing acute pain and enhancing mobility using psychological interventions. There was low-quality evidence that psychological interventions reduce postoperative mental distress. Powell 2016 reported similar findings for adults undergoing elective surgery under general anaesthesia. However, in both reviews, high levels of heterogeneity appeared.

In this update, we aimed to focus on potential causes for heterogeneity to improve the quality of evidence. Therefore, we strived for investigating new high-quality studies to provide the best available and most up-to-date evidence. As research and development constantly prove the correlation between optimism and postoperative outcomes, we aimed to identify new potential psychological interventions which might be available. Considering that improved scales for assessing postoperative pain or mental distress may have been developed, this update is important to prevent the risk of misleading data (See: Cochrane Handbook).

OBJECTIVES

To compare the efficacy of psychological interventions as an adjunct to standard care versus standard care alone or standard care plus attention control in adults undergoing open heart surgery for pain, pain medication, mental distress, mobility, and time to extubation.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomised controlled trials (Higgins 2011d) irrespective of language, publication date or publication status. We limited inclusion to studies with a sample size of at least 20 participants in each trial arm at first postoperative assessment (Moore 2010; Eccleston 2014).

Types of participants

We considered as eligible for inclusion all adult participants (men and women aged 18 and over) undergoing open heart surgery (valve procedures with or without cardiopulmonary bypass (CPB), coronary surgery with or without CPB, congenital lesion, surgery of thoracic aorta, other cardiac surgery, e.g. resection of heart neoplasm and assist devices). We excluded studies on emergency procedures and heart transplantation because participants differ in disease severity and time to be psychologically prepared for surgery, among other factors. We included participants independent of their pre- and postoperative mental health status.

Types of interventions

Experimental intervention

As described above (see 'Description of the intervention' section), we focused on the following types of psychological interventions provided within the time of hospitalisation:

- psychoeducational interventions;
- cognitive-behavioural methods;
- relaxation techniques.

We included studies in which intervention group participants received at least one of the interventions described above.
We excluded studies in which intervention group participants received a combination of a psychological intervention and a nonpsychological intervention.
Studies which focused on lifestyle changes, pharmacological or psychotherapeutic long-term treatment after discharge of high-risk cardiac surgery participants with an a priori or a posterior diagnosis of major depression or anxiety disorder were not in the scope of our review. Long-term psychological interventions included in cardiac rehabilitation programmes have been covered by another Cochrane review (Whalley 2014).
We excluded music interventions, as pain, distress, and anxiety-reducing effects of music in various cardiac participant populations have already been addressed in a recent Cochrane review (Bradt 2013).

Comparator intervention

- 'treatment as usual' (TAU), defined as the standard care of the hospital with no psychological intervention provided to the control group.
- 'attention control', defined as providing the same amount of time and attention, but with no specific psychological intervention offered to the control group.

Types of outcome measures

We reported postoperative outcomes according to the following time intervals.

- 1st interval - short-term effects: outcome measures within the first 48 hours postoperatively.
- 2nd interval - medium-term effects: measures that took place after the first postoperative 48 hours and before discharge.
- 3rd interval - long-term effects: outcome measures after discharge.

Primary outcomes

1. Number of participants with self-reported pain intensity reduction of at least 50% from baseline.

2. Number of participants below 30/100 mm on the visual analogue scale (VAS) in self-reported postoperative pain intensity.

3. Participant-reported postoperative pain intensity measured on continuous or categorical scales, or other participant-reported pain intensity scales or questionnaires with satisfactory reliability and validity.

Secondary outcomes

1. Observer-reported postoperative median time to re-medication.

2. Observer-reported postoperative number of participants re-medicated.

3. Observer-reported postoperative analgesic use measured via participant-controlled analgesia (PCA), with conversion into morphine equivalents.

4. Participant-reported postoperative mental distress (defined as negative affect, anxiety, depression, mood, well-being, relaxation) measured via:

i) Visual analogue scales (VAS), numerical rating scales (NRS), verbal rating scales (VRS);

ii) Profile of Mood Scale (POMS, McNair 1971);

iii) Brief Symptom Inventory (BSI, Derogatis 1983);

iv) State Anxiety form of State-Trait-Anxiety-Inventory (STAI-S, Spielberger 1983);

v) Hospital Anxiety and Depression Scale (HADS, Zigmond 1983);

vi) Other participant-reported psychological distress rating scales with satisfactory reliability and validity.

5. Participant- and observer-reported postoperative levels of mobility measured via, for example, the six-minute walk test (Guyatt 1985).

6. Observer-reported time to extubation.

We preferred dichotomous outcomes if studies reported both continuous and dichotomous outcomes on pain intensity or analgesic use.

We reported the incidence of postoperative complications (see: Table 1); however, we did not run meta-analytic procedures for this outcome as pooling of various postoperative complications with different severity levels leads to pooled heterogeneous estimates with no clear interpretation. Postoperative complications were defined as common consequences or events that were associated with the surgical procedure adversely affecting the participant's prognosis (Jacobs 2007; Rosendahl 2013): myocardial infarction, re-operation, cardiac arrest, prolonged ventilation (> 24 hours), re-thoracotomy, wound infection, renal failure, pneumothorax, pericardial effusion, pleural effusion, arrhythmia, and transient delirium.

Search methods for identification of studies

Electronic searches

For this update we carried out electronic searches in the following databases:

- CENTRAL (the Cochrane Library) February 2017;
- MEDLINE (OVID), Sept 2013 to February week 1, 2017;
- Embase (OVID), Sept 2013 to week 5, 2017;
- Web of Science (ISI), 2013 to 31 January 2017;
- PsycINFO (OVID), 2013 to January week 4, 2017;
- ProQuest Dissertations and Theses Full Text Database, 2013 to August 2016.

A MEDLINE search strategy, based on both indexed and free-text terms and incorporating the Cochrane Highly Sensitive Search Strategy for identifying randomised controlled trials, is shown in Appendix 1. We adapted the strategy for the Cochrane Central Register of Controlled Trials (CENTRAL, Appendix 2), and Embase database (Appendix 3) as well as for PsycINFO (Appendix 4) and Web of Science (Appendix 5). We used the 'related articles' and 'cited by' options of eligible studies to identify additional relevant studies.

Searching other resources

We searched the ProQuest Dissertations and Theses Full Text Database (all years to August 2016) and contacted the first and last author of all included and excluded studies, which were contained in this update, to identify any unpublished material. Furthermore, we requested from fourteen leading heart centres in Germany, Switzerland and Austria whether they could command any unpublished material. Additionally, we scanned ClinicalTrials and the WHO International Clinical Trials Registry Platform to make sure that we detected any potentially unpublished material (all years to August 2016).

Data collection and analysis

Selection of studies

Two review authors (SZ and SK) independently screened titles and abstracts of retrieved articles for eligibility. If a title and abstract looked eligible, we sought the full text to get further information. We resolved disagreements by discussion with a third author (JR).

Data extraction and management

Two review authors (SZ and SK) extracted data independently using a pilot-tested electronic data extraction form. We resolved disagreements through discussion and consultation with a third review author (JR). In order to obtain missing information, we contacted study authors for clarification.

We extracted the following information from primary studies.

- Information on publication (title, authors, year, publication status, language, country).
- Population (clinical participant characteristics, sample size, age, gender).
- Intervention type.
- Control group type.
- Outcomes (time interval of measurement, effect size-related parameters (including frequencies, change scores, means, standard deviations, *t* or *F* values, and probability levels))

Assessment of risk of bias in included studies

Two review authors (SZ and SK) independently assessed the risk of bias for each included study using the Cochrane 'Risk of bias' tool (Higgins 2011a). We assessed the risk of selection bias (random sequence generation, allocation concealment), the risk of attrition bias (incomplete outcome data) and the risk of reporting bias (selective reporting). As blinding of participants and therapists is not possible in psychological intervention research, we assessed the risk of performance bias by evaluating the blinding status of medical personnel only. We defined medical personnel as care providers (physicians, surgeons, nurses) who were not involved in the provision of adjunctive psychological interventions. We assessed the risk of detection bias (blinded outcome assessment) for observer-reported outcomes and for participant-reported outcomes separately. We used a consensus method to resolve disagreements.

Measures of treatment effect

We used the risk ratio (RR) as a measure of treatment effect for all dichotomous outcomes. Additionally, we calculated the number needed to treat for an additional beneficial outcome (NNTB) for dichotomous outcomes. We used Hedges' adjusted g for all continuous outcomes. Hedges' g is similar to Cohen's well-known effect size d, but includes an adjustment to correct for small sample size. It was calculated by dividing the differences in mean values with the pooled standard deviation (Cohen's effect size) multiplied by a small sample size correction factor (Hedges 1981).

Effect sizes of those multi-arm studies with similar psychoeducation intervention groups and a shared control group (Mahler 1998; Mahler 1999) or of studies with a shared intervention group and two different control groups (Pick 1994) are stochastically dependent. We therefore used recommended procedures to account for the correlations among the within-study outcome measures related to multiple comparisons (Gleser 2009; Higgins 2011b). We calculated a weighted average of the pair-wise comparisons and a variance, taking into account the correlation between comparisons (Higgins 2011b). The correlation between within-study effect sizes was set at 0.50 (Wampold 1997). Within-study aggregation of effect sizes was done by using the *R* package MAd (Del Re 2010).

With regard to the continuous primary outcome (self-reported postoperative pain intensity), we prespecified a minimal clinically relevant group mean difference of g = 0.4, corresponding to 10 mm on a 100 mm visual analogue scale (VAS). This difference has been found to be clinically relevant in a randomised controlled study examining effects of relaxation on postoperative pain (Good 1999), since it has been associated with significantly reduced distress and also with reduced heart and respiratory rates moderating sympathetic nervous system activity.

Unit of analysis issues

We measured all outcomes at the participant level.

Dealing with missing data

Whenever possible, we used results from an intention-to-treat (ITT) analysis. If outcome data for dichotomous outcomes were incompletely reported (e.g. the analysis set was smaller than the number of participants randomised), we used the reported analysis population. If standard deviations (SDs) were not provided for continuous outcomes, we calculated them from standard errors or confidence intervals (CI), as described elsewhere (Reichenbach 2007).

Assessment of heterogeneity

We quantified heterogeneity using the I^2 statistic and Tau^2 (Higgins 2002). We estimated Tau^2 using the DerSimonian-Laird method (DerSimonian 1986). We assessed any heterogeneity in subgroup analyses and sensitivity analyses, as described below.

Assessment of reporting biases

We assessed reporting biases and small study effects visually in funnel plots and formally, as described previously (Sterne 2011).

Data synthesis

We meta-analysed outcome data using a random-effects approach. We used the generic inverse variance method with heterogeneity estimated using the DerSimonian-Laird method (DerSimonian 1986).

Many studies used different outcome measures as endpoints. These outcome measures represented different outcome constructs (e.g. pain, mobility, anxiety, depression). Our approach was to define reasonable sets of outcome categories that included different operationalisations but distinguished different content domains of interest (Gleser 2009). Our outcome categories of interest are described in the Methods section (Types of outcome measures). For example, we pooled data for the outcome constructs of anxiety, depression, mood, well-being, negative affect, and relaxation, within the outcome category 'mental distress' across studies. Pooling data from independent participants across studies introduced no bias,

because the studies, and the effect sizes, were statistically independent.

We calculated a treatment versus control effect size for each outcome measure (Measures of treatment effect). Subsequently, we pooled these effects by computing the mean (and its variance) of the effect sizes (Borenstein 2009) from different outcome constructs within an outcome category study. This synthetic summary effect was used as the unit of analysis in the meta-analysis. We only combined outcomes which were measured with the same metric and used the smaller N under the assumption that participants with missing scores on one of the outcome measures had the same mean score on the other outcome measure.

We chose this form of averaging effects because we were interested in a broad range of study results and welcomed diverse measures and constructs. We wanted to use as much information as possible for effect estimation and avoid information loss, hence we decided against a rule for hierarchical outcome data extraction.

Some of the included trials had a more complex data structure and provided multiple measures as endpoints for each subject (multiple-endpoint studies, Gleser 2009). In these studies, we also computed a treatment versus control effect size for each endpoint measure (Measures of treatment effect). However, pooling multiple measures from the same participants within studies introduces bias due to statistical dependency in the data, because multiple measures on the same participants are correlated, and so are corresponding effect sizes. Statistically dependent data are related to a number of problems, e.g. combining statistically dependent effect sizes leads to an improper estimate of the precision of the synthetic summary effect since the standard error for the synthetic summary effect will likely be erroneously small, study weightings will be spuriously precise, the confidence interval too narrow, and statistical significance tests likely to reject more often than the nominal significance level (Borenstein 2009).

Those statistically dependent effect sizes cannot be included in one analysis unless special adjustments are made. Therefore, we followed the recommendation of Gleser 2009 and Borenstein 2009 to overcome those problems, which have important implications for the validity of the results of the meta-analysis.

In order to avoid fundamental problems related to a dependent data structure, we controlled for these dependencies among the estimated effect sizes in the analysis and estimated the between-measures correlations to be $r = 0.50$, as has been suggested by Wampold 1997. We used the formulas for the correlations provided by Gleser 2009 and computed the pooled effect sizes with the statistical R package MAd (Del Re 2010). The MAd aggregation function implements the Gleser 2009 procedures for aggregating dependent effect sizes. By applying these procedures, the estimated effects did not suffer from an improper estimate of the precision.

Some studies reported results on the same variables measured at different times. These outcome measures represented measures of the same construct at different time points (e.g. depression at first postoperative day and depression at second postoperative day). Again, our approach was to use all available information for effect estimation. We therefore considered all time points worth analysing in order to depict the course of postoperative pain and other outcome categories. We followed the recommendation by Gleser 2009 and established broad categories for time intervals and coded each result in the time interval it fitted most closely. In particular, we were interested in short-, medium- and long-term effects of psychological interventions. These time intervals are described in the Methods section (Types of outcome measures).

If studies reported results for different time points (within the same time interval), we combined those effect sizes to an average effect estimation representing the treatment effect for this specific time interval. As has been described above, if data from independent participants were pooled across studies, no bias was introduced. However, if data at different time points (within the same time interval) came from the same participants within a given study, we again applied the procedures described above to account for statistical dependency in the data.

Quality of the evidence

Two review authors (SZ, SK) independently rated the quality of the evidence for each outcome. We used Review Manager to rank the quality of the evidence (RevMan 2014), and the guidelines provided in Chapter 12.2 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011e).

The GRADE approach uses five considerations (study limitations, consistency of effect, imprecision, indirectness and publication bias) to assess the quality of the body of evidence for each outcome. The GRADE system uses the following criteria for assigning grades of evidence:

- High: we are very confident that the true effect lies close to that of the estimate of the effect;
- Moderate: we are moderately confident in the effect estimate; the true effect is likely to be close to the estimate of effect, but there is a possibility that it is substantially different;
- Low: our confidence in the effect estimate is limited; the true effect may be substantially different from the estimate of the effect;
- Very low: we have very little confidence in the effect estimate; the true effect is likely to be substantially different from the estimate of effect.

We decreased the grade rating by one (- 1) or two (- 2) levels if we identified:

- Serious (- 1) or very serious (- 2) limitation to study quality;
- Important inconsistency (- 1);
- Some (- 1) or major (- 2) uncertainty about directness;
- Imprecise or sparse data (- 1);
- High probability of reporting bias (- 1).

Summary of findings' table

We included a 'Summary of findings' table to present the main findings in a transparent and simple tabular format. In particular, we included key information concerning the quality of evidence, the magnitude of effect of the interventions examined, and the sum of available data on the outcomes: number of participants with self-reported pain intensity reduction of at least 50% from baseline, number of participants below 30/100 mm on the visual analogue scale (VAS), participant-reported postoperative pain intensity (measured on continuous scales), analgesic use (measured via PCA), participant-reported postoperative mental distress, mobility, and time to extubation.

Subgroup analysis and investigation of heterogeneity

To identify sources of heterogeneity, we conducted subgroup analyses according to different intervention types (psychoeducational interventions, cognitive-behavioural interventions, relaxation techniques) and control group types (treatment as usual and attention control) (Harbord 2008; Thompson 2002).

Sensitivity analysis

We carried out sensitivity analyses to explore the influence of risk of bias components on effect size estimation (Juni 2001). We tested the robustness of effects against the exclusion of effect sizes being approximated due to missing statistical parameters in primary studies. Accordingly, we carried out a sensitivity analysis with regard to studies with reliable effect estimates from means, standard deviations and sample sizes. We computed sensitivity analyses for all risk of bias domains but reported only those with a significant change to overall findings.

RESULTS

Description of studies

See: Characteristics of included studies and Characteristics of excluded studies.

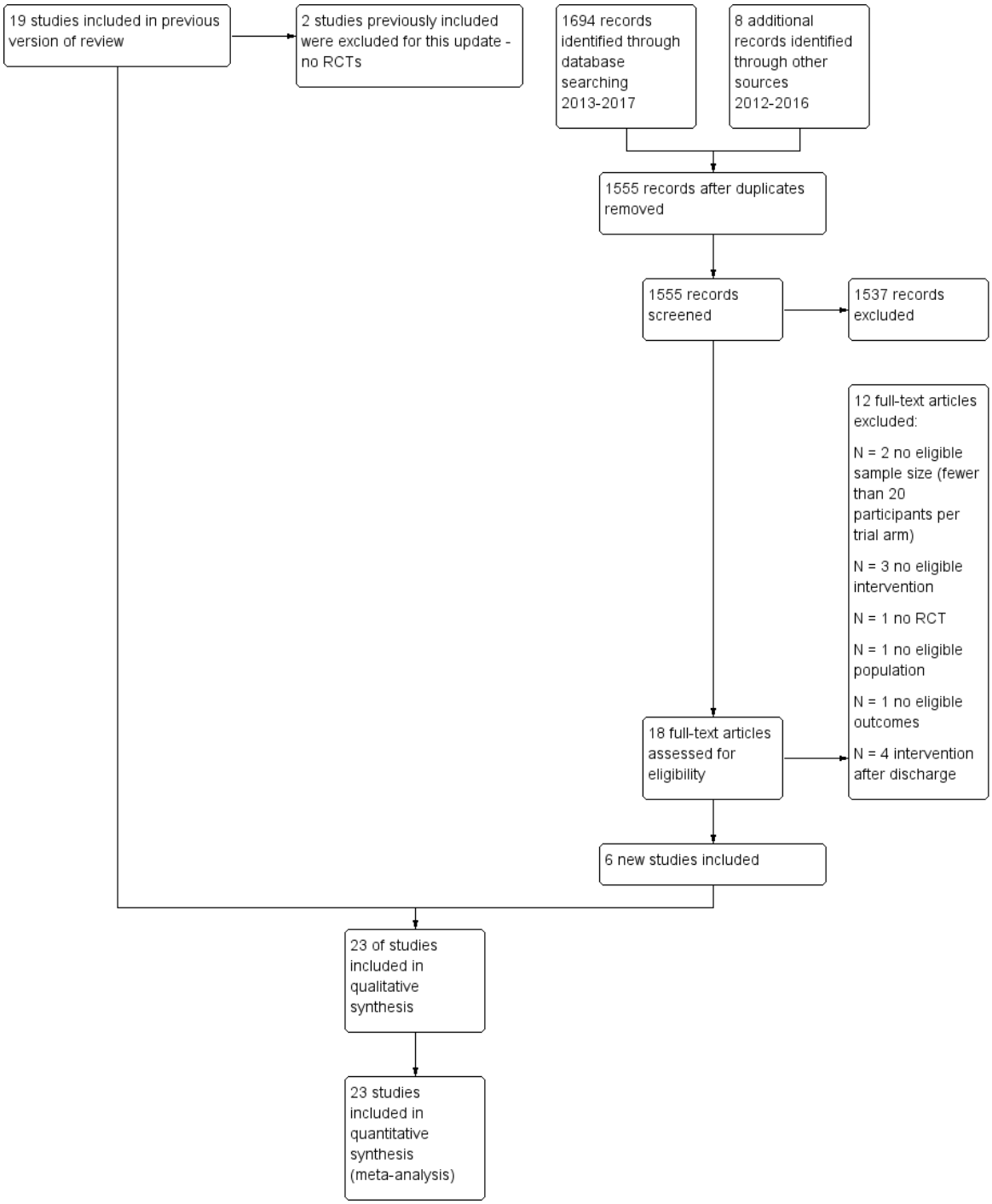
Results of the search

In total, our searches from the original review and from this update identified 7796 studies through electronic database searching, other meta-analyses and other sources. The current search generated 1555 studies after duplicates were removed and we included six new studies in this update (Akgul 2016; Dao 2011; Heilmann 2016; Hoseini 2013; Rief 2017; Zarea 2014). We excluded two studies (Anderson 1987, Heidarnia 2005) which were included in the previous review (Koranyi 2014).

We were not able to identify unpublished material through a search in the ProQuest Dissertation and Thesis Database. Furthermore, we contacted primary and last study authors of all included and excluded studies and all leading heart centres in Germany, Austria and Switzerland to find out whether there were any unpublished studies or ongoing trials. Overall, we had a response rate of 10%, without any additional eligible studies.

Hence, we included a total of 23 studies after scanning them by title and abstract and afterwards checking the full-text articles for inclusion and exclusion criteria in this review (Characteristics of included studies); we excluded 12 studies for this update plus two previously-included studies (30 studies in total) (Characteristics of excluded studies). Figure 1 illustrates the process of screening and selecting studies for inclusion in this updated review.

Figure 1. Study flow diagram.



Included studies

We included 23 randomised controlled clinical trials. Of these, five were from the USA (Dao 2011; Gilliss 1993; Mahler 1998; Mahler 1999; Moore 2001) and another six were conducted in Europe (Austria: Bergmann 2001; Germany: Heilmann 2016; Parthum 2006; Rief 2017; UK: Pick 1994; Norway: Sørlie 2007). Two studies were from Canada (Martorella 2012; Parent 2000) and three from Iran (Hoseini 2013; Zarani 2010; Zarea 2014). One trial each was from Asia (Akgul 2016), Australia (Shelley 2007), China (Guo 2012), Lebanon (Deyirmenjian 2006), South Africa (De Klerk 2004), Taiwan (Ku 2002) and Thailand (Utriyaprasit 2010). All of the 23 included trials were published within the last two decades, with the earliest in 1993 (Gilliss 1993) and the latest in 2017 (Rief 2017). All studies were published in English except one trial, (Parthum 2006), which was published in German. All of the 23 included studies were available as published papers.

Overall, the 23 trials reported data from 2669 participants (1427 with a psychological intervention; 1242 in a control condition). The mean age of intervention group participants was from 52 to 68 years, similar to the range of mean age in control group participants (52 to 69 years). The unweighted mean prevalence of male participants in the intervention groups (80.0%) and control groups (78.9%) was also comparable.

Types of interventions

We considered three different types of psychological interventions provided within the time of hospitalisation (psychoeducation, cognitive-behavioural methods, and relaxation). In the majority of studies, participants received a single type of intervention: most often psychoeducation was implemented (Bergmann 2001; Deyirmenjian 2006; Guo 2012; Hoseini 2013; Ku 2002; Mahler 1998; Mahler 1999; Martorella 2012; Moore 2001; Parent 2000; Parthum 2006; Zarea 2014). Two trials applied relaxation (Akgul 2016; De Klerk 2004; Pick 1994) and one trial (Rief 2017) provided cognitive-behavioural methods exclusively. Eight studies applied two types of interventions: five combined psychoeducation with cognitive-behavioural methods (Dao 2011; Gilliss 1993; Shelley 2007; Sørlie 2007; Zarani 2010), and in two trials a combination of psychoeducation and relaxation was implemented (Heilmann 2016; Utriyaprasit 2010).

Intervention sessions lasted for a minimum 15 minutes (Moore 2001) up to 120 minutes and longer (De Klerk 2004), but with relevant data often not reported in detail. The majority of studies implemented preoperative interventions (Akgul 2016; Bergmann 2001; Deyirmenjian 2006; Guo 2012; Heilmann 2016; Ku 2002; Mahler 1998; Mahler 1999; Parthum 2006; Shelley 2007; Zarani 2010), while Gilliss 1993; Hoseini 2013; Moore 2001; Utriyaprasit 2010 applied interventions postoperatively. Eight trials considered both pre- and postoperative interventions (Dao 2011; De Klerk 2004; Martorella 2012; Parent 2000; Pick 1994; Rief 2017; Sørlie 2007; Zarea 2014).

In six trials, specialist nurses provided the interventions (Gilliss 1993; Guo 2012; Heilmann 2016; Mahler 1998; Mahler 1999; Sørlie 2007), while in one trial, intervention was conducted by a surgeon (Bergmann 2001). Both, researchers (De Klerk 2004; Ku 2002; Martorella 2012; Pick 1994; Shelley 2007; Zarea 2014) and former participants (Mahler 1998; Mahler 1999; Parent 2000) provided interventions, as well. In two trials, clinical psychologists carried out the intervention (Dao 2011; Rief 2017) and in one trial, an anaesthesiologist performed the intervention (Akgul 2016). Only four trials reported that intervention providers received special training (Heilmann 2016; Parent 2000; Rief 2017; Sørlie 2007), while others explicitly stated that there had not been any coaching of intervention providers (Bergmann 2001; Mahler 1998; Mahler 1999). Seven trials referred to a special programme, manual or model (Dao 2011; Ku 2002; Martorella 2012; Moore 2001; Utriyaprasit 2010; Zarani 2010; Zarea 2014).

The intervention format differed across trials. Slide-tapes and telephone contacts (Gilliss 1993; Rief 2017), as well as audio-tapes (De Klerk 2004; Hoseini 2013; Moore 2001; Pick 1994; Utriyaprasit 2010) and video-tapes (Mahler 1998; Mahler 1999; Sørlie 2007; Zarani 2010) were used as formats to implement the intervention content. One of the recent studies used an innovative web application approach (Martorella 2012). However, the majority of trials implemented the intervention (additionally) via a face-to-face contact (Akgul 2016; Bergmann 2001; Dao 2011; De Klerk 2004; Deyirmenjian 2006; Gilliss 1993; Guo 2012; Heilmann 2016; Ku 2002; Martorella 2012; Parent 2000; Parthum 2006; Pick 1994; Rief 2017; Shelley 2007; Sørlie 2007; Zarani 2010; Zarea 2014). Brochures were also common (Guo 2012; Ku 2002; Parthum 2006; Zarani 2010). One trial used a group setting for intervention implementation (Zarani 2010). More than half of the studies combined at least two types of intervention formats. Most commonly a face-to-face contact was combined with a brochure (Guo 2012; Ku 2002; Parthum 2006; Zarani 2010) or an audio- (De Klerk 2004; Pick 1994) or video-tape (Sørlie 2007; Zarani 2010).

Types of comparators

Most trials used TAU control groups (Bergmann 2001; Dao 2011; De Klerk 2004; Deyirmenjian 2006; Gilliss 1993; Guo 2012; Heilmann 2016; Hoseini 2013; Mahler 1998; Mahler 1999; Martorella 2012; Moore 2001; Parent 2000; Parthum 2006; Shelley 2007; Sørlie 2007; Zarea 2014). Four studies referred to attention control groups exclusively (Akgul 2016; Ku 2002;

Utriyaprasit 2010; Zarani 2010), while Pick 1994 and Rief 2017 comprised both a TAU control and an attention control group. Apart from three trials with three treatment arms (Mahler 1999; Pick 1994; Rief 2017) and one study with four treatment arms (Mahler 1998), all other studies comprised two treatment arms.

Two attention control groups used emotional support (Pick 1994) and supportive counselling (Zarani 2010), while participants in a further three attention control groups received cardiac teaching combined with discharge instructions (Utriyaprasit 2010) or preoperative nursing care combined with a 10-minute social visit daily during hospitalisation (Ku 2002). One attention control group only used cognitive-behavioural methods (Rief 2017) and another study applied relaxation (Akgul 2016).

Types of outcomes

Primary outcome

The primary outcome of participant-reported pain intensity was assessed in six trials (the number of participants below 30/100 mm on the VAS by Parthum 2006; and pain intensity on continuous scales by Akgul 2016; Guo 2012; Martorella 2012; Shelley 2007; Utriyaprasit 2010). One of the primary outcomes (number of participants with self-reported pain intensity reduction of at least 50% from baseline) was not reported in any of the included trials.

Secondary outcomes

The most frequently assessed outcome was postoperative mental distress. Participant-reported levels of postoperative mental distress were measured with the Hospital Anxiety and Depression Scale (Guo 2012; Hoseini 2013; Martorella 2012; Rief 2017; Zarani 2010; Zarea 2014), the Profile of Mood Scale (De Klerk 2004; Gilliss 1993; Moore 2001; Utriyaprasit 2010) and the State-Trait-Anxiety-Inventory (Bergmann 2001; Dao 2011; Ku 2002; Parent 2000). However, the majority of studies used other psychological distress rating scales (Bergmann 2001; Dao 2011; De Klerk 2004; Deyirmenjian 2006; Heilmann 2016; Mahler 1999; Pick 1994; Shelley 2007; Sørlie 2007).

The observer-reported time to extubation (Akgul 2016; Deyirmenjian 2006) as well as the observer-reported postoperative analgesic use measured via participant-controlled analgesia (PCA) (Akgul 2016; Martorella 2012) were extracted from two trials each. Five studies measured self- and observer-reported postoperative levels of mobility (Gilliss 1993; Mahler 1998; Parent 2000; Rief 2017; Utriyaprasit 2010). Three studies reported postoperative complications (Deyirmenjian 2006; Martorella 2012; Parent 2000, see Table 1).

We reported outcome measures according to the three time intervals: short-term effects (within the first 48 hours postoperatively), medium-term (after the first postoperative 48 hours and before discharge), and long-term (outcome measures after discharge). Only six trials assessed short-term intervention effects (Akgul 2016; Deyirmenjian 2006; Martorella 2012; Parthum 2006; Pick 1994; Zarea 2014). More often, the outcomes were assessed after the first postoperative 48 hours and before discharge (Bergmann 2001; Dao 2011; De Klerk 2004; Deyirmenjian 2006; Guo 2012; Heilmann 2016; Ku 2002; Mahler 1998; Mahler 1999; Martorella 2012; Shelley 2007; Sørlie 2007; Utriyaprasit 2010), or after discharge of the participants (De Klerk 2004; Gilliss 1993; Hoseini 2013; Mahler 1999; Moore 2001; Parent 2000; Pick 1994; Rief 2017; Shelley 2007; Sørlie 2007; Utriyaprasit 2010; Zarani 2010; Zarea 2014). While the earliest postoperative measurement took place after awaking from anaesthesia (Deyirmenjian 2006), the longest follow-up assessment was conducted two years after discharge (Sørlie 2007).

Excluded studies

We excluded 30 studies (See Characteristics of excluded studies) due to the following reasons: the sample size was fewer than 20 participants in each group at first postoperative assessment (Ashton 1997; Fredericks 2013; Hojskov 2016; Houston 1999; Postlethwaite 1986; Stein 2010; Watt-Watson 2000); the intervention was exclusively provided before admission to hospital (Cupples 1991; Hermele 2005; Lamarche 1998; Shuldham 2002; Watt-Watson 2004); the intervention was provided exclusively after discharge (Bjornnes 2017; Chair 2013; Doering 2013; Hartford 2002; Keeping-Burke 2013); the intervention was not eligible for inclusion (virtual reality for physiotherapeutic treatment, Cacau 2013; Hemi-Sync tape, Ikedo 2007; combined intervention of psychological and physiotherapeutic elements, Kalogianni 2016 and Sibilitz 2013; similar-other support, Thoits 2000); study was not randomised (Anderson 1987; Heidarnia 2005; Martorella 2014); no open heart surgery (Kol 2014; Yin 2011); no eligible outcomes (Shamansouri 2013); nonelective open heart surgery (Blankfield 1995); participants under 18 years of age (Hwang 1998).

Risk of bias in included studies

Figure 2 and Figure 3 depict a graphical representation of the 'Risk of bias' assessments.

Figure 2. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

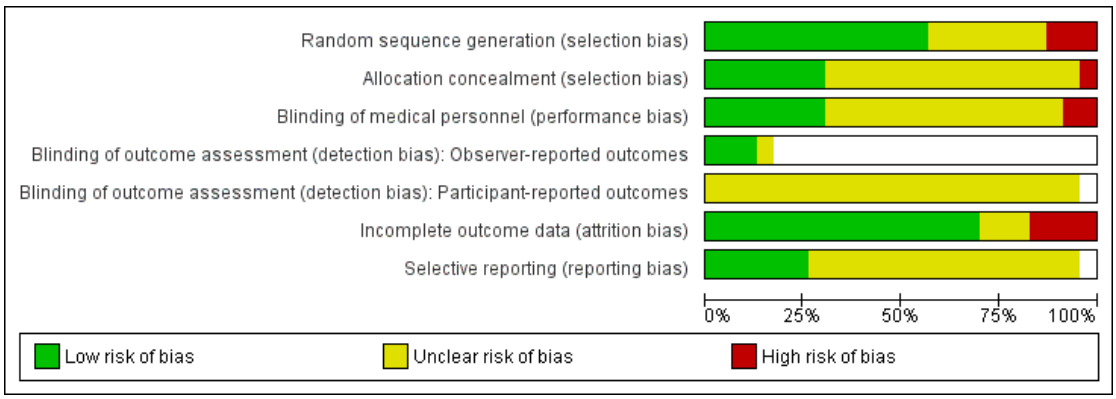
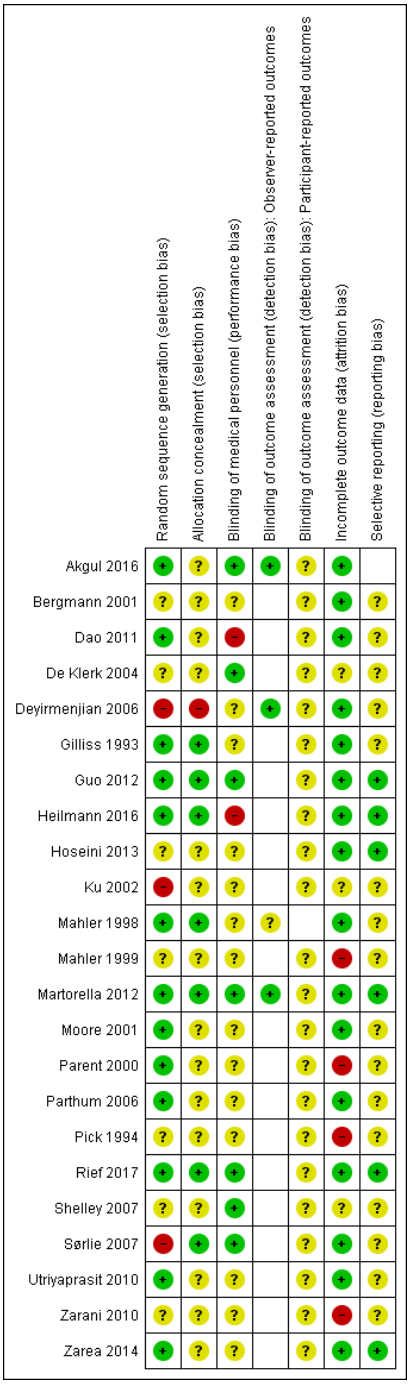


Figure 3. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.



Allocation

We classified thirteen of the 23 randomised controlled trials as being at low risk of bias due to an adequate random sequence generation (Akgul 2016; Dao 2011; Gilliss 1993; Guo 2012; Heilmann 2016; Mahler 1998; Martorella 2012; Moore 2001; Parent 2000; Parthum 2006; Rief 2017; Utriyaprasit 2010; Zarea 2014), whereas three trials did not use adequate methods for random sequence generation and were classified as being at high risk of bias (Deyirmenjian 2006; Ku 2002; Sørlie 2007). Only seven trials applied an appropriate method to conceal the random allocation sequence (Gilliss 1993; Guo 2012; Heilmann 2016; Mahler 1998; Martorella 2012; Rief 2017; Sørlie 2007), while we rated only one study as being at high risk of bias (Deyirmenjian 2006).

Blinding

Blinding of medical personnel (performance bias)

Seven trials (Akgul 2016; De Klerk 2004; Guo 2012; Martorella 2012; Rief 2017; Shelley 2007; Sørlie 2007) used adequate methods to blind medical personnel (physicians, surgeons, nurses) to participants' group assignment and were rated as being at low risk of performance bias. Two trials (Dao 2011; Heilmann 2016) were classified as being at high risk of bias due to no use of adequate methods to blind medical personnel.

Blinding of outcome assessment (detection bias)

Observer-reported outcomes

In trials with observer-reported outcome measures, we rated one trial as being at unclear risk of detection bias (Mahler 1998) due to insufficient information related to blinding status of the outcome assessors. We judged three trials to be at low risk of detection bias since they used blinded outcome assessors for postoperative analgesic use (Akgul 2016; Martorella 2012) and time to extubation (Akgul 2016; Deyirmenjian 2006). All other remaining 19 studies did not include observer-reported outcomes, therefore, it was not possible to assess the risk of detection bias for "observer-reported outcomes" and the columns in Figure 3 are blank for this domain.

Participant-reported outcomes

The majority (22/23) of trials used self reports of pain intensity, mental distress, and mobility as outcome measures (Akgul 2016; Bergmann 2001; Dao 2011; De Klerk 2004; Deyirmenjian 2006; Gilliss 1993; Guo 2012; Heilmann 2016; Hoseini 2013; Ku 2002; Mahler 1999; Martorella 2012; Moore 2001; Parent 2000; Parthum 2006; Pick 1994; Rief 2017; Shelley 2007; Sørlie 2007; Utriyaprasit 2010; Zarani 2010; Zarea 2014), and we judged them to be at unclear risk of detection bias. One study (Mahler 1998) did not include participant-reported outcomes, therefore, it was not possible to assess the risk of detection bias for 'participant-reported outcomes' and the column in Figure 3 is blank for this domain.

Incomplete outcome data

Sixteen trials used adequate methods of incomplete outcome data handling and we rated them as being at low risk (Akgul 2016; Bergmann 2001; Dao 2011; Deyirmenjian 2006; Gilliss 1993; Guo 2012; Heilmann 2016; Hoseini 2013; Mahler 1998; Martorella 2012; Moore 2001; Parthum 2006; Rief 2017; Sørlie 2007; Utriyaprasit 2010; Zarea 2014). We rated four trials (Mahler 1999; Parent 2000; Pick 1994; Zarani 2010) as being at high risk of bias because of deficient reporting according to the handling of incomplete data.

Selective reporting

It has been suggested that definitive evidence that selective reporting has not occurred requires access to the study protocol that will have been published before the trial started (Higgins 2011a). However, only six study protocols were available (Guo 2012; Heilmann 2016; Hoseini 2013; Martorella 2012; Rief 2017; Zarea 2014). For the remaining 17 studies we assumed an unclear risk of reporting bias.

Effects of interventions

See: **Summary of findings for the main comparison** Summary of findings (short-term); **Summary of findings 2** Summary of findings (medium-term); **Summary of findings 3** Summary of findings (long-term)

We reported results for all the available outcome measures specified above.

1 Main comparison

Psychological interventions versus control condition

We included 23 trials (2669 participants) comparing psychological interventions against a control condition. In our meta-analyses, the control condition was either standard care or attention, with two studies including the comparison of a psychological intervention to both a standard care control group and an attention control group (Pick 1994; Rief 2017).

Primary outcome measures

Number of participants with self-reported pain intensity reduction of at least 50% from baseline

No study reported data on the number of participants with participant-reported pain intensity reduction of at least 50% from baseline. Therefore, we could not rate the quality of evidence.

Number of participants below 30/100 mm on visual analogue scale (VAS) in self-reported postoperative pain intensity

Data on the number of participants below 30/100 mm on VAS pain intensity in the short term were only provided by one study (73 participants; Parthum 2006). Psychological interventions did not reduce pain intensity below 30/100 mm on the Visual Analogue Scale: risk ratio (RR) 1.20 (95% confidence interval (CI) 0.68 to 2.12). The number needed to treat for one additional beneficial outcome (NNTB) was 14 (95% CI -9 to 3). We rated the quality of evidence as very low due to limitations in design, indirectness and imprecision (Summary of findings for the main comparison).

Participant-reported postoperative pain intensity measured with continuous scales

Two studies (104 participants, Akgul 2016; Martorella 2012) reported data on short-term effects of a psychological intervention on pain intensity measured with continuous scales (g 0.39, 95% CI -0.18 to 0.96) indicating no reduction of participant-reported postoperative pain in the psychological intervention group. We rated the quality of evidence as low due to limitations in indirectness and imprecision (Summary of findings for the main comparison). Likewise, psychological interventions did not reduce pain intensity in the medium-term (g -0.02, 95% CI -0.24 to 0.20, I^2 = 34%, four studies, 413 participants, Analysis 1.2). We rated the quality of evidence as moderate because of inconsistency (Summary of findings for the main comparison). In line, long-term effects (g 0.05 95% CI -0.20 to 0.30, I^2 = 0%, two studies, 200 participants, Analysis 1.3) did not show a reduction of pain intensity measured with continuous scales. Due to sparse data (imprecision), we rated the quality of evidence as moderate (Summary of findings for the main comparison).

Since we prespecified g 0.4 as a minimal clinically relevant group mean difference, the identified effect sizes cannot be regarded as clinically relevant.

Secondary outcome measures

Observer-reported postoperative analgesic use

Only two trials (104 participants; Akgul 2016; Martorella 2012) provided data on postoperative analgesic use. Analgesic use within the first 48 hours after surgery (short-term interval) was not reduced (g 1.18, 95% CI -2.03 to 4.39). Because of indirectness and imprecision, we rated the quality of evidence as low (Summary of findings for the main comparison). No reduction of analgesic use was found after the first postoperative 48 hours and before discharge (medium-term interval: g 0.18, 95% CI -0.37 to 0.72). We rated the quality of evidence as low due to the same limitations which were used in the short-term interval (Summary of findings for the main comparison). There were no long-term measures (post-discharge) for this outcome and therefore we could not rate the quality of evidence.

Participant-reported postoperative mental distress

Only one study (Pick 1994; 74 participants) reported short-term data within the first 48 hours after surgery, and found no reduction of postoperative mental distress in the psychological intervention group (g 0.00, 95% CI -0.44 to 0.44). We rated the quality of evidence as low because of indirectness and imprecision (Summary of findings for the main comparison). Psychological interventions reduced mental distress after the first postoperative 48 hours and before discharge (g 0.37, 95% CI 0.13 to 0.60, I^2 = 83%, thirteen studies, 1388 participants, Analysis 1.5) and we rated the quality of evidence as moderate due to inconsistency (Summary of findings for the main comparison). In the long-term interval (0.32, 95% CI 0.10 to 0.53; I^2 = 78%, 14 studies, 1586 participants, Analysis 1.6), psychological interventions also reduced mental distress. We rated the quality of evidence as moderate because of inconsistency (Summary of findings for the main comparison).

Participant- and observer-reported postoperative levels of mobility

No study reported short-term effects on mobility and therefore we could not rate the quality of evidence. Psychological interventions did not improve mobility in the medium term (g 0.23, 95% CI -0.22 to 0.67, I^2 = 80%, three studies, 444 participants, Analysis 1.7) and, because of inconsistency and imprecision, we rated the quality of evidence as low (Summary of findings for the main comparison). In the long-term (g 0.09, 95% CI -0.10 to 0.28, I^2 = 17%, four studies, 458 participants, Analysis 1.8), psychological interventions also did not improve mobility and we rated the quality of evidence as moderate because of imprecision (Summary of findings for the main comparison).

Observer-reported time to extubation

Data on time to extubation after surgery (short-term interval) were provided by only two trials (154 participants; Akgul 2016; Deyirmenjian 2006). In those studies, psychological interventions reduced observer-reported time to extubation (g 0.56, 95% CI 0.08 to 1.03). We rated the quality of evidence as low because of indirectness and imprecision (Summary of findings for the main comparison).

There were no data available for the other secondary outcomes: observer-reported postoperative median time to re-medication or observer-reported postoperative number of participants re-medicated and therefore we could not rate the quality of evidence.

2 Subgroup analysis

2.1 Psychological interventions versus standard care (TAU)

Primary outcome measures

Number of participants with self-reported pain intensity reduction of at least 50% from baseline

No study reported data on the number of participants with participant-reported pain intensity reduction of at least 50% from baseline.

Number of participants below 30/100 mm on VAS in self-reported postoperative pain intensity

Only one study reported data on the number of participants below 30/100 mm on VAS pain intensity (73 participants; Parthum 2006). There were no differences in the number of participants who reported pain intensity below 30/100 mm on the VAS in the short-term interval (RR 1.20, 95% CI 0.68 to 2.12; number needed to treat for an additional beneficial outcome (NNTB) was 14.

Participant-reported postoperative pain intensity measured with continuous scales

One study (60 participants, Martorella 2012) reported data on short-term effects of psychological interventions on pain intensity measured with continuous scales (g 0.10, 95% CI -0.28 to 0.48) indicating no significant difference between the psychological intervention and the standard care control group. Likewise, psychological interventions did not reduce pain intensity measured with continuous scales compared to standard care (TAU) in the medium-term (g 0.09, 95% CI -0.11 to 0.29, I^2 = 0%, three studies, 293 participants, Analysis 2.1) or long-term (g 0.03 95% CI -0.40 to 0.46, one study, 80 participants, Analysis 2.2). Since we prespecified g 0.4 as a minimal clinically relevant group mean difference, the identified effect sizes cannot be regarded as clinically relevant.

Secondary outcome measures

Observer-reported postoperative median time to re-medication

None of our included studies reported data on observer-reported postoperative median time to re-medication.

Observer-reported postoperative number of participants re-medicated

None of our included studies reported data on observer-reported postoperative number of participants re-medicated.

Observer-reported postoperative analgesic use

Data on postoperative analgesic use were provided only in one trial (60 participants; Martorella 2012). Psychological interventions did reduce analgesic use within the first 48 hours after surgery (g 0.44, 95% CI 0.00 to 0.89). The same study showed no effect of psychological interventions compared to standard care control in analgesic use after the first postoperative 48 hours and before discharge (medium-term interval) (g 0.18, 95% CI -0.37 to 0.72).

Participant-reported postoperative mental distress

Only one study (49 participants; Pick 1994) reported short-term data within the first 48 hours after surgery, with no difference between psychological interventions and standard care (g 0.00, 95% CI -0.44 to 0.44). After the first postoperative 48 hours and before discharge, statistically significant medium-term effects in favour of psychological interventions were found on mental distress (g 0.38, 95% CI 0.12 to 0.64; I^2 = 84%, 11 studies, 1208 participants, Analysis 2.2) as well as a long-term effect after discharge (0.41, 95% CI 0.18 to 0.65; I^2 = 76%, 12 studies, 1224 participants, Analysis 2.3).

Participant- and observer-reported postoperative levels of mobility

Studies showed that psychological interventions did not improve mobility compared to standard care in the medium-term interval (g 0.42, 95% CI -0.07 to 0.91, I^2 = 71%, 2 studies, 324 participants, Analysis 2.4) as well as in the long-term interval (g 0.26, 95% CI -0.10 to 0.63, I^2 = 63%, 3 studies, 301 participants, Analysis 2.5).

Observer-reported time to extubation

Only one trial (110 participants; Deyirmenjian 2006) provided data on time to extubation after surgery in the short-term interval, indicating no difference of psychological interventions compared to standard care (g 0.37, 95% CI -0.00 to 0.75).

2.2 Psychological intervention versus attention control group

Primary outcome measures

Participant-reported postoperative pain intensity measured with continuous scales

One study (44 participants, Akgul 2016) reported data on short-term effects of psychological interventions on pain intensity measured with continuous scales (g 0.68, 95% CI 0.32 to 1.04), indicating a reduction of postoperative pain intensity by using psychological interventions. Pain intensity for medium- and long-term was reported in only one trial using a continuous scale (120 participants; Utriyaprasit 2010) indicating no difference between psychological interventions and the attention control group in the medium-term interval (g -0.33, 95% CI -0.69 to 0.03) as well as in the long-term interval (g 0.06, 95% CI -0.25 to 0.37).

Other primary outcomes

There were no data available for the primary outcomes: number of participants with self-reported pain intensity reduction of at least 50% from baseline and number of participants below 30/100 mm on VAS in self-reported postoperative pain intensity.

Secondary outcome measures

Observer-reported postoperative analgesic use

One study (44 participants, Akgul 2016) provided data on postoperative analgesic use in the short-term interval, indicating that psychological interventions reduce the need of analgesic medication (g 2.83, 95% CI 2.00 to 3.67).

Participant-reported postoperative mental distress

Only one study (50 participants; Pick 1994) reported short-term data within the first 48 hours after surgery, revealing no effect (g 0.00, 95% CI -0.44 to 0.44). We found no difference between psychological interventions and attention control group in the medium term (g 0.34, 95% CI -0.53 to 1.21; I^2 = 87%, 2 studies, 180 participants, Analysis 3.1) and long-term effects (g 0.01, 95% CI -0.21 to 0.23; I^2 = 40%, 4 studies, 424 participants, Analysis 3.2).

Participant- and observer-reported postoperative levels of mobility

Only one study measured mobility (120 participants; Utriyaprasit 2010), showing no difference between psychological interventions and attention control group in the medium-term interval (g -0.13, 95%CI -0.44 to 0.18). Two studies reported data on postoperative mobility in the long-term interval (194 participants; Rief 2017; Utriyaprasit 2010), presenting no improvement by comparing psychological interventions and attention control groups (g 0.00, 95%CI -0.24 to 0.24).

Observer-reported time to extubation

One study (44 participants, Akgul 2016) reported data on time to extubation within the first 48 hours (short-term), showing that psychological interventions reduce the time to extubation (g 0.87, 95% CI 0.25 to 1.49).

Other secondary outcomes

There were no data available for the other secondary outcomes: observer-reported postoperative median time to re-medication and observer-reported postoperative number of participants re-medicated.

2.3 Psychoeducation versus control condition

Primary outcome measures

There were no data available for the primary outcomes: participant-reported postoperative pain intensity measured with continuous scales, number of participants with self-reported pain intensity reduction of at least 50% from baseline and number of participants below 30/100 mm on VAS in self-reported postoperative pain intensity

Secondary outcome measures

Participant-reported postoperative mental distress

Psychoeducation did not reduce mental distress in the medium-term interval (g 0.36, 95% CI -0.00 to 0.72; I^2 = 82%, 7 studies, 725 participants, Analysis 4.1). Psychoeducation did reduce mental distress in the long-term interval (g 0.52, 95% CI 0.01 to 1.02; I^2 = 77%, five studies, 606 participants, Analysis 4.2).

Other secondary outcomes

There were no data available for the other secondary outcomes: participant- and observer-reported postoperative levels of mobility, observer-reported postoperative analgesic use, observer-reported postoperative median time to re-medication, observer-reported postoperative number of participants re-medicated, and observer-reported time to extubation.

2.4 Relaxation versus control condition

Primary Outcomes

Participant-reported postoperative pain intensity measured with continuous scales

Only one study (44 participants, Akgul 2016) reported data of postoperative pain intensity in the short-term interval, indicating that relaxation reduces postoperative pain intensity (g 0.68, 95% CI 0.32 to 1.04).

There were no data available for the other primary outcomes: number of participants with self-reported pain intensity reduction of at least 50% from baseline and number of participants below 30/100 mm on VAS in self-reported postoperative pain intensity.

Secondary Outcomes

Observer-reported postoperative analgesic use

One study (44 participants, Akgul 2016) provided data on postoperative analgesic use in the short-term interval, indicating that psychological interventions reduce the need of analgesic medication (g 2.83, 95% CI 2.00 to 3.67).

Participant-reported postoperative mental distress

One study (50 participants; De Klerk 2004) reported data comparing relaxation against a control condition on mental distress in the medium-term interval. Results revealed a reduction of mental distress in favour of relaxation (g 1.15, 95% CI 0.67 to 1.63), whereas relaxation did not reduce mental distress in the long-term interval (g 0.67, 95% CI -0.65 to 2.00, I^2 = 94%, 2 studies, 124 participants, Analysis 5.1).

Observer-reported time to extubation

One study (44 participants, Akgul 2016) reported data on time to extubation within the first 48 hours (short-term), showing that psychological interventions reduce the time to extubation (g 0.87, 95% CI 0.25 to 1.49).

Other secondary outcomes

There were no data available for the other secondary outcomes: observer-reported postoperative median time to re-medication, observer-reported postoperative number of participants re-medicated and participant- and observer-reported postoperative levels of mobility.

2.5 Combined intervention versus control condition

Primary Outcomes

There were no data available for the primary outcomes: number of participants with self-reported pain intensity reduction of at least 50% from baseline, number of participants below 30/100 mm on VAS in self-reported postoperative pain intensity, and participant-reported postoperative pain intensity measured with continuous scales.

Secondary Outcomes

Participant-reported postoperative mental distress

Studies comparing a combination of psychological interventions against a control condition did not reduce mental distress in the medium-term interval (g 0.24, 95% CI -0.07 to 0.56, I^2 = 79%, 5 studies, 613 participants, Analysis 6.1), nor in the long-term

interval (g 0.14, 95% CI -0.08 to 0.37, I^2 = 72%, 6 studies, 693 participants, Analysis 6.2).

Other secondary outcomes

There were no data available for the other secondary outcomes: participant- and observer-reported postoperative levels of mobility, observer-reported postoperative analgesic use, observer-reported postoperative median time to re-medication, observer-reported postoperative number of participants re-medicated, and observer-reported time to extubation.

3 Sensitivity analyses

We carried out sensitivity analyses to explore 1) the effects of 'risk of bias' components as well as to test the robustness of effects against 2) the exclusion of effect sizes being approximated due to missing statistical parameters in studies and 3) the exclusion of effect sizes which were not reliably estimated by means, standard deviations and sample sizes. We computed sensitivity analyses for each outcome separately. Only those sensitivity analyses with a significant change to overall findings are reported and shown in Data and analyses.

3.1 Studies with adequate sequence generation

Studies with adequate sequence generation reported data on mental distress in the medium-term interval (g 0.48, 95% CI 0.08 to 0.87, I^2 = 88%, 6 studies, 704 participants, Analysis 7.1), indicating that the reduction of mental distress with psychological interventions in the medium-term interval (Analysis 1.5) is still robust in studies with adequate sequence generation.

In contrast, the long-term interval (g 0.27, 95% CI 0.00 to 0.54, I^2 = 72%, 7 studies, 771 participants, Analysis 7.2) revealed a broader confidence interval compared to Analysis 1.6, indicating that the effect of reducing mental distress in psychological interventions in the long-term interval was no longer found in studies with adequate sequence generation.

3.2 Studies with adequate handling of incomplete outcome data

The effect of reduction of mental distress by using psychological intervention in the medium-term interval (Analysis 1.5) persisted in studies with adequate handling of incomplete outcome data (medium-term: g 0.23, 95% CI 0.01 to 0.46, I^2 = 74%, 8 studies, 916 participants, Analysis 8.1).

In line, in the long-term interval (Analysis 1.6) the reduction of mental distress was still found in studies with adequate handling of incomplete outcome data (long-term: g 0.28, 95% CI 0.02 to 0.55, I^2 = 74%, 8 studies, 920 participants, Analysis 8.2).

3.3 Studies with study protocol available

Studies for which a study protocol was available revealed a broader confidence interval for data on mental distress in the medium-term interval (g 0.23, 95% CI -0.10 to 0.55, I^2 = 76%, 3 studies, 420 participants, Analysis 9.1) as compared to Analysis 1.5, indicating that the effect of psychological interventions in reducing mental distress was no longer found in studies with a study protocol available.

ADDITIONAL SUMMARY OF FINDINGS *[Explanation]*

Psychological interventions compared with control conditions for acute pain after open heart surgery (medium-term)

Patient or population: adults undergoing open heart surgery
Settings: inpatient, surgical care
Intervention: psychological intervention
Comparison: control condition (either standard care or attention)
Medium-term: outcome measured after the first postoperative 48 hours and before discharge

Outcomes	Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
Number of participants with self-reported pain intensity reduction of at least 50% from baseline	-	-	-	No data available
Number of participants below 30/100 mm on the visual analogue scale (VAS) in self-reported postoperative pain intensity	-	-	-	No data available
Pain intensity measured with continuous scales measured with a range of scales[1]	g -0.02 (-0.24 to 0.20)	413 participants (4 studies)	⊕⊕⊕◯ **moderate** [c]	
Analgesic use measured via PCA	g 0.18 (-0.37 to 0.72)	104 participants (2 studies)	⊕⊕◯◯ **low** [a,b]	
Mental distress measured with a range of scales[1]	g 0.37 (0.13 to 0.60)	1388 participants (13 studies)	⊕⊕⊕◯ **moderate** [c]	
Mobility measured with a range of scales[1]	g 0.23 (-0.22 to 0.67)	444 participants (3 studies)	⊕⊕◯◯ **low** [a,c]	
Time to extubation	-	-	-	No data available

CI: 95% Confidence interval;
g: Hedge´s g: a positive effect size indicates a reduction of pain intensity and mental distress, as well as an enhancement of mobility

[1]We listed the range of scales and additional information in the Characteristics of included studies

GRADE Working Group grades of evidence
High quality: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate quality: we are moderately confident in the effect estimate; the true effect is likely to be close to the estimate of effect, but there is a possibility that it is substantially different.
Low quality: our confidence in the effect estimate is limited; the true effect may be substantially different from the estimate of the effect.
Very low quality: we have very little confidence in the effect estimate; the true effect is likely to be substantially different from the estimate of effect

[a] Downgraded once for imprecision due to wide confidence intervals
[b] Downgraded once for indirectness due to indirect evidence for psychological interventions in general (e.g. if in included studies only one specific intervention program was implemented, than evidence on the effects of psychological interventions outside these specific program may be indirect).
[c] Downgraded once for inconsistency due to heterogeneity $I^2 > 50\%$

Psychological interventions compared with control conditions for acute pain after open heart surgery (long-term)

Patient or population: adults undergoing open heart surgery
Settings: inpatient, surgical care
Intervention: psychological intervention
Comparison: control condition (either standard care or attention)
Long-term: outcome measured after discharge

Outcomes	Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
Number of participants with self-reported pain intensity reduction of at least 50% from baseline	-	-	-	No data available
Number of participants below 30/100 mm on the visual analogue scale (VAS) in self-reported postoperative pain intensity	-	-	-	No data available
Pain intensity measured with continuous scales measured with a range of scales[1]	g 0.05 (-0.20, 0.30)	200 participants (2 studies)	⊕⊕⊕◯ **moderate** [a]	
Analgesic use measured via PCA	-	-	-	No data available

Mental distress measured with a range of scales[1]	g 0.32 (0.10 to 0.53)	1586 participants (14 studies)	⊕⊕⊕◯ **moderate** [b]
Mobility measured with a range of scales[1]	g 0.09 (-0.10 to 0.28)	458 participants (4 studies)	⊕⊕⊕◯ **moderate** [a]
Time to extubation	-	-	- No data available

CI: 95% Confidence interval;
g: Hedge´s g: a positive effect size indicates a reduction of pain intensity and mental distress, as well as an enhancement of mobility

[1]We listed the range of scales and additional information in the Characteristics of included studies

GRADE Working Group grades of evidence
High quality: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate quality: we are moderately confident in the effect estimate; the true effect is likely to be close to the estimate of effect, but there is a possibility that it is substantially different.
Low quality: our confidence in the effect estimate is limited; the true effect may be substantially different from the estimate of the effect.
Very low quality: we have very little confidence in the effect estimate; the true effect is likely to be substantially different from the estimate of effect

[a] Downgraded once for imprecision due to wide confidence intervals
[b] Downgraded once for inconsistency due to heterogeneity $I^2 > 50\%$

DISCUSSION

Summary of main results

This systematic review update investigated the efficacy of psychological interventions (psychoeducation, cognitive-behavioural methods and relaxation) in adults undergoing open heart surgery. Twenty-three randomised-controlled trials (2669 participants) provided data on pain intensity, analgesic use, mental distress, mobility, and time to extubation.

Psychological interventions for participants undergoing open heart surgery did not reduce postoperative pain intensity, irrespective of time interval.

There have been no data available at any time interval for the secondary outcomes, observer-reported postoperative median time to re-medication and observer-reported postoperative number of participants re-medicated. For the secondary outcome of mental distress, results indicated that psychological interventions reduce mental distress in people undergoing open heart surgery in the medium-term and the long-term interval. Postoperative analgesic use was reported in only two trials, showing no reduction of postoperative analgesic use by performing psychological interventions in the short-term interval or in the medium-term interval. Time to extubation was also assessed in only two trials revealing a positive effect in favour of psychological interventions in the short-term interval. However, these initial findings require replication from other research teams to improve confidence in these findings. The evidence for the effect of psychological interventions on postoperative mobility was based on three studies in the medium-term interval, showing that psychological interventions did not improve postoperative mobility. Four studies in the long-term interval showed no improvement of psychological interventions on postoperative mobility. For the remaining outcomes, data could not be meta-analysed due to lack of data and therefore, no conclusions could be drawn.

The majority of included studies provided insufficient information

to derive a 'risk of bias' judgement (Figure 2; Figure 3). More than 50% of the studies did not adequately report information on methods of allocation concealment or blinding, and were rated as being at unclear risk of bias. It is therefore not clear whether such studies were poorly conducted (rated as high risk of bias) or whether those studies were well designed but poorly documented.

Overall completeness and applicability of evidence

This review update summarised the efficacy of various types of psychological interventions and treatment formats. Included studies differed in the applied interventions and incorporated a variety of intervention time points and treatment providers. Additionally, the diversity of hospital settings and healthcare systems of different countries increased the external validity of our results. On the other hand, the completeness and applicability of evidence were restricted due to the following reasons.

A majority of the primary and secondary outcomes (two-thirds of outcomes) were either not assessed in any of the studies, or were only assessed in a small number of studies. None of the primary studies reported the number of participants with pain intensity reduction of at least 50% from baseline (primary outcome), and only one study reported the number of participants scoring their pain below a threshold of 30/100 mm on a VAS. Although the experience of severe acute postoperative pain in the first 48 hours during ICU stay is one of the most disturbing problems in people undergoing open heart surgery, only three studies reported measures of pain intensity within this short-term interval (Akgul 2016; Parthum 2006; Martorella 2012). The evidence base for our main objectives was therefore very sparse. The rarity of this assessment might be explained by difficulties for participants in communicating during their ICU stay, since the presence of an endotracheal tube, residual effects of anaesthesia, sedative agents, and changes in level of consciousness restrict communication to head nodding or upper limb movements (Ayasrah 2014; Gelinas 2007).

Neither the postoperative median time to re-medication, nor the number of participants re-medicated, was reported in primary studies. We therefore could not draw any conclusions about the efficacy of psychological interventions on these parameters, known as an important key outcome of acute pain management (PaPaS 2011).

Only four studies used observer-reported outcome measures (Akgul 2016; Deyirmenjian 2006; Mahler 1998; Martorella 2012), while the majority of studies used self-reported outcome measures only. Self-reported outcomes are frequently used in psychological intervention research, and are particularly important in evaluating the effects of psychological interventions on subjective outcomes like pain intensity and mental distress, since the participant's perspective is regarded as the most relevant. However, in trials with self-reported outcomes, the outcome assessment is not blinded since the outcome assessors are the participants themselves, who are aware of the treatment content and might subsequently deduce their treatment allocation. It is plausible that participants' outcome assessments were biased, because participants may have been given differing expectations of their recovery by study and medical personnel, which may have influenced their outcome assessments. Furthermore, it cannot be ruled out that participants may have formed their own treatment expectations based on knowledge of their treatment allocation, which in turn could have an impact on their judgement (Higgins 2011a). However, there is currently no clear evidence on whether non-blinded self-reports lead to an over- or underestimation of treatment effects for subjective outcomes in psychological intervention trials. We therefore assigned an unclear risk of detection bias to the corresponding trials. Moreover, it is not clear whether self-reported improvement in subjective outcomes is more sensitive to change than observer-reported measures. It has been demonstrated that self-reported measures and observer-rated measures do not necessarily give equivalent assessments of intervention effects for depression (Cuijpers 2010). Future trials should consider credible placebo-control groups to minimise the risk that social desirability bias influences participant outcomes (Quality of the evidence).

Some of the measures (e.g. Beck Anxiety Inventory, Beck 1988; Beck Depression Inventory, Beck 1996) are designed for clinical samples and are prone to produce floor effects in nonclinical samples, even with baseline measures of depression and anxiety being elevated in the context of cardiac surgery. Some studies used rating scales for mental distress, mobility, or pain that are not routinely applied in clinical practice or research (e.g. Postoperative Affect Scale (Sime 1976), and Well-being Scale (Zerssen 1970)). The reliability and validity of these measures might be limited, leading to unreliable data. However, our new included studies only used measures which are routinely used for participants undergoing cardiac surgery. We therefore recommend the use in future trials of psychometrically sound instruments which are common in routine practice and research.

Seven studies used skills teaching (e.g. relaxation procedure) or a taped intervention which participants had to apply by themselves (De Klerk 2004; Heilmann 2016; Hoseini 2013; Moore 2001; Pick 1994; Sørlie 2007; Utriyaprasit 2010). Only Moore 2001 and Utriyaprasit 2010 measured adherence to the intervention and found acceptable adherence rates. The other five studies did not provide data on adherence. Although listening to a tape was only one part of the interventions, it is possible that nonadherence of participants might have reduced the effects of these interventions. Measuring adherence should therefore be considered in future trials, to rule out nonadherence effects on intervention efficacy.

Performance bias results from systematic differences between groups in the care that is provided (Higgins 2011a). In pharmacological treatment studies, controlling for performance bias is typically achieved through the blinding of participants and study personnel to the treatment condition. In psychological intervention trials, it is improbable that treatment delivery can be double-

blind, as therapists will know what they are delivering and participants will also be aware of treatment content. Nonblinding of participants could bias the results by affecting the outcomes (Overall completeness and applicability of evidence). This may, for example, be due to a lack of expectations for treatment success in a control group (Higgins 2011a). In psychological intervention trials, the prevention of performance bias can partly be addressed by strategies to compensate for the lack of blinding, e.g. by ensuring equivalence of treatment credibility and structural equivalence if different interventions are compared (Baskin 2003). Another strategy to account for the risk of performance bias is the assessment of expectations of treatment benefits and to ask the participants to guess their allocation (Baskin 2003).

Our review comprises substantial clinical diversity across studies in the intervention (contents, provider, dose, and duration) and outcome measures (e.g. various ways to assess mental distress or mobility). Consequently, tests of statistical heterogeneity indicated a large amount of heterogeneity in the analyses. However, subgroup analyses and sensitivity analyses could not explain the sources of heterogeneity. It is reasonable to assume that other moderators (e.g. dose and duration of intervention) might be present which have not been considered for data analyses.

Subgroup analyses of the type of intervention for outcomes other than mental distress were not feasible, due to the small number of trials for each outcome, so we do not know how different intervention methods might work for these outcomes. However, future updates of this review may include more studies enabling us to conduct these analyses. The applicability of results is currently limited, due to a relatively small number of eligible randomised controlled trials (RCTs) with small sample sizes.

Quality of the evidence

Three 'Summary of findings' tables are presented in this update review. First, the results of the short-term outcomes are presented (Summary of findings for the main comparison). Due to a lack of data, we were not able to estimate an effect for those respective outcomes. We judged all of the other outcomes in this table to be low or very low quality. Reasons for those judgements were small sample sizes and wide confidence intervals, high statistical heterogeneity and indirect evidence for psychological interventions in general by implementing only one type of psychological intervention in each study.

Second, the results of the medium-term outcomes are presented (Summary of findings 2). Again, we were not able to assess certain outcomes, due to the absence of data. We judged all of the other outcomes in this table to be low or moderate quality. Contributing reasons for this were wide confidence intervals, high statistical heterogeneity and, again, the indirect evidence for psychological interventions in general.

Third, Summary of findings 3 presents the results of the long-term outcomes. In line with the short-term and medium-term outcomes, we were not able to estimate several outcomes because of the absence of data. Regarding the existence of wide confidence intervals and high levels of statistical heterogeneity, we assessed all of the evidence for the other outcomes to be of moderate quality.

Potential biases in the review process

Since we adhered strictly to Cochrane guidelines (Higgins 2011c, Chandler 2013, PaPaS 2011), potential biases should have been reduced. However, some bias might have been introduced.

We attempted to minimise publication bias by performing a comprehensive literature search and including studies without language restrictions. We contacted each author of an included study in order to identify unpublished study material. We received an answer from ten primary study authors who were not aware of any unpublished trial or ongoing studies. In order to receive additional data, we got in contact with all big heart centres in Germany, Switzerland, and Austria with the result that three heart centres negated any unpublished trials or ongoing studies. Furthermore, we searched the ProQuest Dissertation and Thesis Database to identify any unpublished studies. However, we were not able to retrieve any unpublished studies, and all 23 included studies were published papers. We did not find evidence of publication bias with regard to the secondary outcome mental distress measured in the medium-term and the long-term interval. Visually the funnel plots for the outcomes 'mental distress: medium-term' (Figure 4) and 'mental distress: long-term' (Figure 5) appeared not asymmetrical. We used the test proposed by Egger et al (Egger 1997) to formally test funnel plot asymmetry and obtained no significant evidence of small-study effects (medium-term: P = 0.1256; long-term: P = 0.0615). We did not use the Egger test for the other outcomes, because Sterne 2011 advises against the use of the test with substantially fewer than 10 studies.

Figure 4. Funnel plot of comparison: 1 Psychological intervention vs control condition, outcome: 1.3 Mental distress: medium-term.

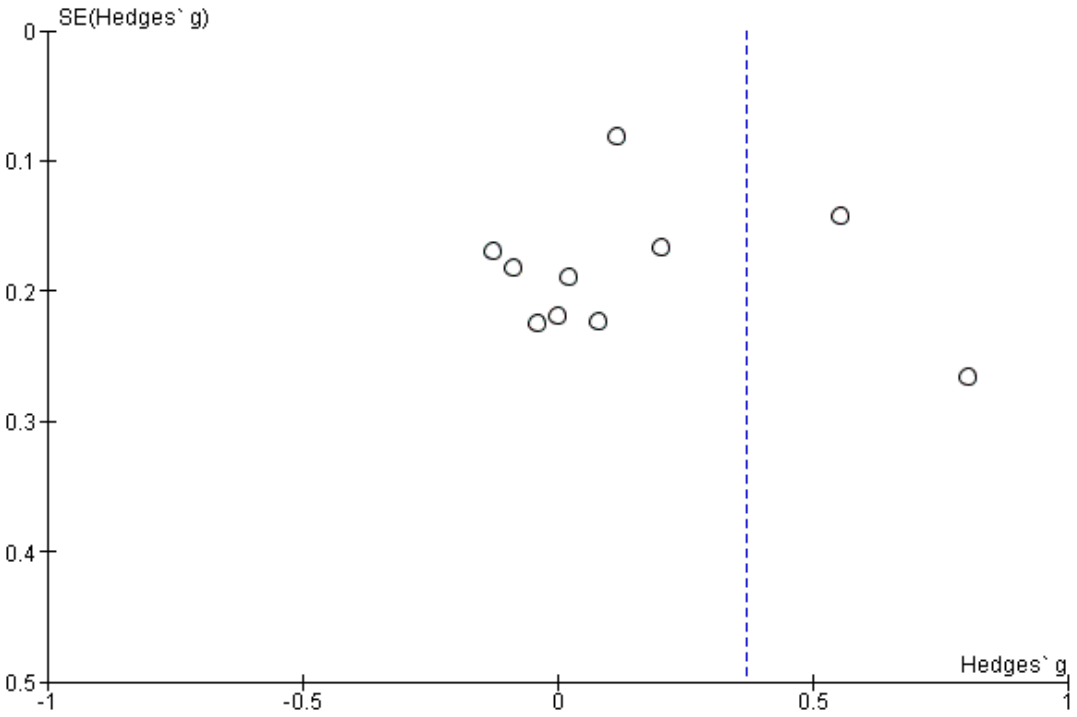
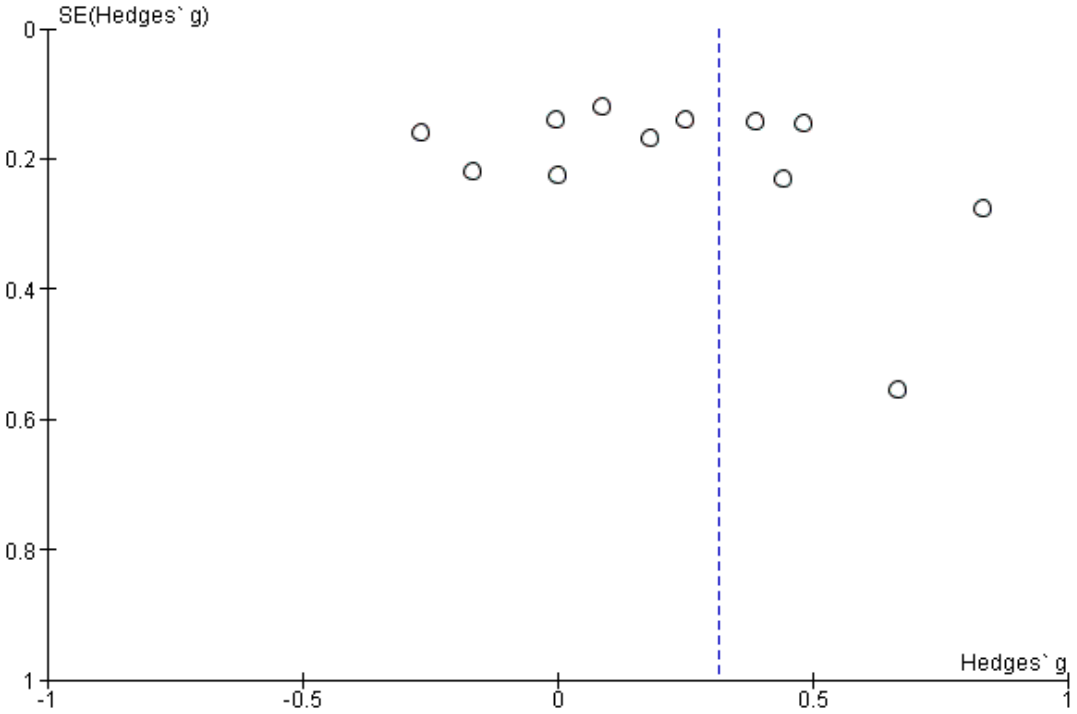


Figure 5. Funnel plot of comparison: 1 Psychological intervention vs control condition, outcome: 1.4 Mental distress: long-term.



To avoid potential bias in the process of selecting studies, two review authors independently screened titles and abstracts of retrieved articles, with recourse to a third review author in cases of disagreement. Data extraction was also independently performed in duplicate by two review authors, and a consensus data set for each study was used for meta-analyses. We resolved disagreement by consultation with a third review author.

Missing statistical parameters in primary studies are a well-known source of bias. In one study, missing information could be retrieved by personal contact with the author who supplied information that was not extractable from the manuscript (Shelley 2007). In another trial, nonsignificant results were mentioned without reporting any related statistical parameters (Pick 1994); hence, we used a conservative approach and set effect estimates to zero. Other studies failed to provide standard deviations for each group (Gilliss 1993; Zarani 2010). Hence, we had to calculate standard deviations from standard errors, or to estimate them from studies using the same scale and measurement time point. However, a sensitivity analysis of the robustness of meta-analysis results showed no change after exclusion of the studies with missing information (Shelley 2007; Pick 1994; Gilliss 1993; Zarani 2010).

Agreements and disagreements with other studies or reviews

We compared the results of our review with previous systematic reviews investigating the effects of psychological interventions during hospital stay in people undergoing surgery, similar painful procedures, or people with coronary heart disease.

Johnston 1993 investigated the effectiveness of preoperative psychological interventions in adults undergoing elective surgical procedures under general anaesthesia. They included 38 randomised controlled trials comparing psychological interventions to treatment-as-usual or attention control group. Johnston 1993 excluded two trials that were also excluded from our review because of small sample size (Postlethwaite 1986) and nonrandom allocation procedure (Surman 1974). Results of Johnston 1993 are in line with the findings of our review with respect to mental distress, but not with respect to pain and pain medication. For the latter outcomes, the Johnston 1993 review found moderate to large effects in favour of psychological interventions.

One intervention trial included in the present review (De Klerk 2004) is also included in the review of Schnur 2008, which investigated the effects of hypnotherapeutic interventions in children and adults undergoing medical procedures. Schnur 2008 sum-

marized data of 26 randomised controlled trials comparing hypnotherapeutic interventions against treatment-as-usual or attention control group. They also included another two trials with cardiac surgery participants that were excluded from the present review for reasons of small sample size (Ashton 1997) and inclusion of nonelective participants (Blankfield 1995). The results of Schnur 2008 are comparable to the present review; hypnosis was found to be effective to reduce emotional distress associated with medical procedures.

In a Cochrane review of 24 trials, Whalley 2014 systematically reviewed the effects of psychological interventions within cardiac rehabilitation for people with coronary heart disease. In line with the findings in our review, Whalley 2014 concluded that psychological interventions resulted in small improvements in depression and anxiety.

A recent Cochrane review of 105 trials examined whether psychological preparation had impact on the outcomes of postoperative pain, behavioural recovery, length of stay, and negative affect. Powell 2016 suggested that psychological preparation may reduce postoperative pain even though those results were subject to restrictions according to heterogeneity. They included five trials which were also included in this present review update (Bergmann 2001; Guo 2012; Mahler 1998; Parthum 2006; Shelley 2007). In addition, they included seven trials which were excluded in this review update (Ashton 1997; Heidarnia 2005; Lamarche 1998; Postlethwaite 1986; Shuldham 2002; Watt-Watson 2000; Watt-Watson 2004) for different reasons (see: Characteristics of excluded studies). With respect to the pain outcome, Powell 2016 interpreted the data of 38 studies which reported a small beneficial effect in reducing postoperative pain and a high level of heterogeneity. In contrast to our review, Powell 2016 included all adult participants undergoing elective surgery under general anaesthesia and not only open heart surgery participants, which might explain the difference from our results. However, in line with our results, Powell 2016 presented a small beneficial effect for psychological interventions compared with control conditions and a high level of heterogeneity.

Protogerou 2015 investigated the moderators of the effect of psychological interventions on depression and anxiety in cardiac surgery participants. Twenty-four trials fitted the inclusion criteria for the systematic review and 16 of them were meta-analysed. Two of these trials were also included in our review (Dao 2011; Sørlie 2007), while the authors included two trials which were excluded in this review update because either the intervention started after discharge (Doering 2013) or the trial had a small sample size fewer than 20 participants in each group at postoperative assessment (Stein 2010). The results indicated a large beneficial effect in reducing anxiety and depression which is in line with the data of the four newly included studies in the present review update. As Protogerou 2015 excluded studies in which psychological interventions aimed to modify outcomes other than psychological distress (e.g. morbidity, mortality, adherence to medication, exercise, bodily symptoms), the difference from our results might be explainable. However, in accordance with our review update, psychological interventions had a beneficial effect in reducing anxiety and depression in cardiac surgery participants.

AUTHORS' CONCLUSIONS

Implications for practice

For people with acute pain after open heart surgery

There is no evidence that psychological interventions reduce postoperative pain in people undergoing open heart surgery. Limited data were available and future studies are likely to change the conclusions reported here. There was moderate quality of evidence that psychological interventions reduced mental distress. Analyses revealed no effects of psychological interventions to enhance mobility or to reduce the time to extubation. Again, there was considerable uncertainty around these conclusions due to limited data.

For clinicians

We found that psychological interventions which were delivered face-to-face in a one-to-one setting were highly effective in reducing mental distress (Dao 2011; De Klerk 2004; Parent 2000; Zarea 2014). In addition, a considerable reduction of mental distress was achieved with multiple therapeutic contacts instead of one visit only. Also, clinicians should accompany, if possible, people after discharge as well to retain the positive intervention effects on mental distress reduction. No intervention method (e.g. psychoeducation, relaxation or cognitive-behavioural approach) was superior to others or less effective than other intervention methods.

For policy makers and funders of the intervention

The current evidence does not clearly support the use of psychological interventions to reduce postoperative pain. However, there was moderate-quality evidence that psychological interventions could reduce postoperative mental distress. Moreover, psychological interventions seemed to be cost-effective and quite easy to implement.

Implications for research

Design

The majority of studies did not provide information about skills or competence of the treatment provider (e.g. formal qualification or training). Training and qualifications, as well as checking that

sessions conform to the named treatment methods, are important aspects of quality assurance, as psychological interventions rely very much on the skills of the practitioner. Future trials should describe the qualifications and training of the staff, and should include session checks on competence and adherence in their study design.

It might be reasonable to assume the presence of participant variables which moderate the effects of psychological interventions. Thus, future study designs should investigate moderating variables. For example, it has been shown for people with cancer that those with higher levels of mental distress may benefit more from psychological interventions than those with normal levels of mental distress, or those with only a marginally increased level (Coyne 2006; Hart 2012). There are further findings indicating that control appraisals do moderate the effect of psychoeducational interventions on distress and pain (Shelley 2007). There might be subgroups of participants who are unaffected or who even experience more distress after the intervention than they would have experienced without it. Future studies should report results for subgroups of participants in order to examine differential effects.

Future study designs should also focus on the underlying mechanisms of psychological interventions in the context of cardiac surgery, as these mechanisms are not yet understood. One possible underlying mechanism might be participants' adherence to medical treatment recommendations. It might be reasonable to expect that people undergoing open heart surgery with reduced mental distress after surgery are more adherent to medical treatments, recommendations for lifestyle change and participation in cardiac rehabilitation, as has already been shown for people recovering from acute coronary events (Glazer 2002; Rieckmann 2006; Sin 2016; Ziegelstein 2000). Understanding how psychological interventions work is crucial to designing psychological interventions that target active change mechanisms.

The large heterogeneity in effects on mental distress needs to be explained in future research. Some studies yielded very large positive effects on the reduction of mental distress, and some studies showed no effects of psychological interventions on mental distress. Considering only studies with very large positive effect sizes (Dao 2011; De Klerk 2004; Parent 2000; Zarea 2014), we detected that multiple face-to-face contacts in one-to-one settings, which are extended beyond discharge seem to be specifically effective in reducing postoperative mental distress. These aspects (longer treatment duration and psychological treatment even after discharge) might lead to a more profound therapeutic relationship, which is one of the most important factors to influence treatment outcome (Lambert 2001) and could therefore explain the beneficial effects; these should therefore be in the scope of future studies.

Future trials should test the extent to which psychological interventions contribute any specific effects above and beyond the nonspecific effects of additional attention and caring support received during hospitalisation. Thus, more clinical trials with attention control group as comparators in their study design are needed (e.g. Akgul 2016; Rief 2017).

Measurement (endpoints)

For the majority of outcomes (two-thirds), we could not perform a meta-analysis because either the outcomes were not measured, or data were only provided by one trial. Since our review was limited by a lack of data for primary and secondary outcomes (particularly dichotomous pain outcome data), future trials which report adequate pain outcomes are urgently needed.

The quality of evidence for benefits of psychological interventions on mental distress was moderate. The meta-analysis results suggested that psychological interventions might have the potential to enable participants to cope successfully with stresses of open heart surgery. Successful coping prevents the development of an adjustment disorder or a reactive type of depression, which in turn have been hypothesised to be associated with the aetiology of postoperative depression (Peterson 2002). Several studies have demonstrated an association between postoperative depression and mortality or cardiac events after cardiac surgery, although the behavioural and biological mechanisms are as yet poorly understood (see for a review Tully 2012; Tully 2015). Further studies are required to evaluate the long-term effects of in-hospital psychological interventions in people undergoing cardiac surgery on the development of postoperative depression and subsequently occurring cardiac events.

In our meta-analysis, we did not evaluate any harm associated with psychological interventions since none of the primary studies reported any adverse intervention effects. Adverse events might be of interest to the population of people undergoing open heart surgery, and should be collected in forthcoming trials, as studies in people after a critical life event have shown some negative effects of psychological interventions.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Akgul 2016

Methods	Randomised controlled trial. Study duration: 8 months. Date study was conducted: January 2011 to August 2011.
Participants	*Setting* *Inclusion criteria* Elective CABG that required an extracorporal bypass system. *Exclusion criteria* History of mental and affective disorders. Cerebrovascular disease. Previous CABG surgery. Taking psychotropic medications. Participants who had urgent and/or emergency coronary artery surgery, beating (i.e. CABG without cardiopulmonary bypass system), and robotic CABG *Baseline data* N = 44 (intervention 22, control 22). Male gender: intervention 77.3%, control 81.8%. Mean age: intervention 54.2 years, control 55 years. LVEF: intervention 49.2%, control 48.2%.
Interventions	*Routine care for all participants* All participants had received information about the surgical procedure and postoperative process and CABG interventions were performed by the same surgical team *Control group* Attention control group; Routine care. To eliminate the placebo effect of hypnosis as well as emotional/mood variations, the hypnotherapist had an interview with participants of the control group for a similar period of time as the intervention group *Intervention group* Relaxation; Hypnosis. The hypnotherapist used an indirect permissive approach technique; participants were instructed to focus their attention on an object or memory, specific positive goals of anxiety, fear, control, and relaxation were introduced (suggestion phase, duration: 30 minutes), and participants were told to feel relaxed and calm during the perioperative period, the hypnotherapist induced the participant to restore contact with their surroundings, hypnosis was performed on the participants after the first evaluation of the anxiety indexes (on the same day that they were hospitalised)
Outcomes	*Postoperative pain intensity* Present pain. Visual analogue scale (VAS). Continously measured (lower scores indicated lower pain).

Akgul 2016 (*Continued*)

	Participant-reported. 1st interval (1st, 2nd, 4th, 6th, 8th, 10th, 12th, and 24th hours after surgery) *Time to extubation* Hours to extubation after awakening from anaesthesia. Continuous measure (higher scores indicated negative effect) Observer-reported. 1st interval (after awakening from anaesthesia). No adverse events reported. *Postoperative analgesic use (PCA)* Opioid dose (morphine equivalents). Continous measure (higher levels indicated higher dose). Observer-reported. 1st interval (within the first 24-hours postoperatively). No adverse events reported.
Notes	Sources of funding: not reported. Conflicts of interest: not reported.

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation.
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding of medical personnel (performance bias)	Low risk	"The surgeon, other physicians, anesthesiologists, data collectors, the statistician, the patients as well as the nurses providing postoperative analgesia were blinded to assignment of groups."
Blinding of outcome assessment (detection bias) Observer-reported outcomes	Low risk	"(...) the patient was considered for extubation by the physician who was blinded as to which group the patients were in."
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported outcome.
Incomplete outcome data (attrition bias) short-term	Low risk	No missing data.

Bergmann 2001

Methods	Randomised controlled trial. Study duration: not reported. Date study was conducted: not reported.
Participants	*Setting* University Clinic Graz, Austria. *Inclusion criteria* Elective open heart surgery participants. *Exclusion criteria* Acute or recent myocardial infarction (within the last 6 weeks) Percutaneous transluminal coronary angioplasty. Angina unresponsive to medical therapy and participant therefore scheduled for urgent operation Intake of psychopharmaceuticals or thyroid hormones before surgery Participants waiting for more than 3 days for their operation *Baseline data* N = 60 (intervention 30, control 30). Coronary artery bypass surgery 65%, heart valve operation 35% (ejection fraction: intervention 58%; control 56%) Male gender: intervention 60%; control 53%. Mean age: intervention 62 years; control 59 years. NYHA (New York Heart Association) II + IV 86.7%.
Interventions	*Routine care for all participants* Routine medical information through informative pamphlet with 2 illustrations covering 4 points (preoperative course and preparation for the operation, surgical technique, postoperative course, possibility of intra- and postoperative complications) *Control group* Routine care (TAU). *Intervention group* Psychoeducation. Extensive oral information given preoperatively by surgeon (same information as in pamphlet), opportunity to talk about perioperative concerns or personal problems (twice a day, at least 20 mins) Surgeon had no training in psychotherapy but was supervised by a graduate psychotherapist before the study
Outcomes	*Postoperative mental distress* Anxiety. State-Trait Anxiety Inventory (STAI, Spielberger 1970), state anxiety score. Continuous measure (score ranged from 20 to 80, higher scores indicated higher anxiety) Participant-reported. 2nd interval (6th postoperative day). *Postoperative mental distress* Well-being. Well-being Scale (Zerssen 1970).

Bergmann 2001 (*Continued*)

	Continuous measure (lower scores indicated positive condition) Participant-reported. 2nd interval (6th postoperative day). No adverse events reported.
Notes	Sources of funding: not reported. Conflicts of interests: not reported.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not described.
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding of medical personnel (performance bias)	Unclear risk	Not described.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported outcome.
Incomplete outcome data (attrition bias) short-term	Low risk	Only 1 of 30 participants in the intervention group did not complete the study, reasons stated, no differences in baseline measures from rest of the group
Selective reporting (reporting bias)	Unclear risk	No discrepancies between outcomes listed in the methods section and outcomes reported in the results section of the trial, however, study protocol was not available to compare outcomes of the protocol and reported outcomes

Dao 2011

Methods	Randomised controlled trial. Date study was conducted: February 2007 to May 2009.
Participants	*Setting* Veterans affairs hospital. *Inclusion criteria* Coronary artery diagnosis and scheduled a first time CABG operation without concomitant valve procedures Significant symptoms of depression and/or anxiety. *Exclusion criteria*

	Serious medical illness (other than CAD). Psychiatric instability, schizophrenia, bipolar disorder, active alcoholism, or substance abuse, severe cognitive impairment, noncardiac illness with a poor 1-year prognosis Previous exposure to cognitive-behavioural treatment within the past year Receiving ongoing psychotherapeutic services. Use of psychotropic medications (e.g. antidepressant medication) for more than 4 weeks *Baseline data* N = 100 (intervention 50, control 50). Left ventricular ejection fraction: intervention 52.3%; control 49.1% Male gender: intervention 77.1%; control 79.6%. Mean age: intervention 62.8 years; control 64.2 years. NYHA class: intervention 2.92; control 2.88.
Interventions	*Routine care for all participants* Not described. *Control group* Routine care (TAU). *Intervention group* Psychoeducation, cognitive-behavioural intervention. Managing Anxiety and Depression using Education and Skills (MADES) Four 60-minute treatment sessions, which were videotaped administered by two clinical psychologists Session 1 (before surgery): overview of study, education about CAD, surgery, depression/anxiety, etc.), overview of CBT to identify concerns Session 2 (before surgery): review behavioural goals, introduce cognitive strategies Session 3 (three days after surgery): review cognitive distortions and strategies, continue to support and encourage Session 4 (five days after surgery): review materials, generate plan for continued change, continue to support and encourage
Outcomes	Postoperative mental distress. Depression. Beck Depression Inventory-II (BDI-II; Beck 1996). Self-reported measure (21 items; scores of 14 or greater were used to indicate significant symptoms of depression) 2nd interval (in-hospital follow-up). 3rd interval (3 to 4 weeks of follow-up). Postoperative mental distress. Anxiety. State-Trait Anxiety Inventory (STAI). Self-reported measure of trait or dispositional anxiety (20 items; 40 or greater were used to indicate significant symptoms of anxiety 2nd interval (in-hospital follow-up). 3rd interval (3-4 weeks of follow-up).
Notes	Sources of funding: not reported. Conflicts of interest: "Authors have nothing to disclose with regard to commercial report. "

Dao 2011 (*Continued*)

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Participants were "randomly assigned using a random numbers table to receive TAU or a brief form of CBT" p. 110
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding of medical personnel (performance bias)	High risk	"Study was not able to blind the surgeons to which group the patients were assigned" p.115
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported.
Incomplete outcome data (attrition bias) short-term	Low risk	Missing outcome data balanced in numbers and similar reasons for missing data across groups N = 2 participants in intervention group and N = 2 participants in control group were lost to follow-up. p. 111.
Selective reporting (reporting bias)	Unclear risk	No discrepancies between outcomes listed in the methods section and outcomes reported in the results section of the trial, however, study protocol was not available to compare outcomes of the protocol and reported outcomes

De Klerk 2004

Methods	Randomised controlled trial. Study duration: not reported. Date study was conducted: not reported.
Participants	*Setting* Unitas hospital, Pretoria, Gauteng Province, South Africa. *Inclusion criteria* Participants undergoing coronary artery bypass surgery. *Exclusion criteria* Not described. *Baseline data*

De Klerk 2004 (*Continued*)

	N = 50 (intervention 25, control 25). Male gender: 100%. Mean age: 56 years. Education: 12 years.
Interventions	*Routine care for all participants* Not described. *Control group* Routine care (TAU). *Intervention group* Relaxation. Hypnotherapeutic ego strengthening, including a progressive relaxation induction and a special place deepening technique; a metaphor focusing on spiritual inner strength and age progression was introduced; 2nd session included a preoperative rehearsal Preoperatively, 2 x 60-minute sessions individually in a private room the evening preceding surgery and the morning thereof Repetition of inner strength and age progression intervention on audiocassette 3 postoperative sessions, 1 session daily, voice of principal investigator, used with classical music
Outcomes	*Postoperative mental distress* Depression. Beck Depression Inventory (BDI-II, Beck 1996). Continuous measure (sum of 21 items, scores ranging from 0 to 63; higher scores indicated progressively severe levels of depression) Participant-reported. 2nd interval (at discharge). 3rd interval (6 weeks postoperatively). *Postoperative mental distress* Depression. Profile of Mood States (POMS, McNair 1992) - subscale depression. Continuous measure (higher scores indicated greater depression) Participant-reported. 2nd interval (at discharge). 3rd interval (6 weeks postoperatively). *Postoperative mental distress* Anxiety. Profile of Mood States (POMS, McNair 1992) - subscale anxiety. Continuous measure (higher scores indicated greater anxiety) Participant-reported. 2nd interval (at discharge). 3rd interval (6 weeks postoperatively). No adverse events reported.

De Klerk 2004 (*Continued*)

Notes	Sources of funding: not reported. Conflicts of interest: not reported.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not described.
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding of medical personnel (performance bias)	Low risk	"Nursing personnel caring for the two groups in the ICU and relevant open wards received no education or insight, so as not to influence participants´ responses" (p. 83)
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported outcome.
Incomplete outcome data (attrition bias) short-term	Unclear risk	Not described.
Selective reporting (reporting bias)	Unclear risk	No discrepancies between outcomes listed in the methods section and outcomes reported in the results section of the trial, however, study protocol was not available to compare outcomes of the protocol and reported outcomes

Deyirmenjian 2006

Methods	Randomised controlled trial. Study duration: not reported. Date study was conducted: not reported.
Participants	*Setting* Cardiac surgery unit, University hospital in Beirut, Lebanon *Inclusion criteria* Less than 80 years old. First time, coronary artery bypass surgery. *Exclusion criteria* History of psychiatric disorder. Spouse operated for coronary artery bypass surgery.

Deyirmenjian 2006 (*Continued*)

	Baseline data N = 110 (intervention 57, control 53). Male gender: intervention 83%; control 84%. Mean age: intervention 62.4 years; control 58.6 years. Married: intervention 83%; control 86%. Education: intervention 16.4 years; control 16.3 years. Employed: intervention 53%; control 60%.
Interventions	*Routine care for all participants* Routine hospital protocol almost without preoperative education *Control group* Routine care (TAU). *Intervention group* Psychoeducation. Preoperative educational session including conversations about what to expect in the Cardiac Surgery Unit in terms of equipment used, visiting hours for the family members; followed by an explanation and demonstration of respiratory exercises, leg exercises, and possible complications; discussion of pain management and early ambulation; possibility of answering questions; tour to the cardiac surgery unit
Outcomes	*Postoperative mental distress* Anxiety. Beck Anxiety Inventory (BAI, Beck 1988), Arabic version. Continuous measure (sum of 21 items, total score ranged from 0 to 63, higher scores indicated greater anxiety) Participant-reported. 2nd interval (2 days before discharge). *Time to extubation* Hours to extubation after awakening from anaesthesia. Continuous measure (higher scores indicated negative effect) Observer-reported. 1st interval (after awakening from anaesthesia). No adverse events reported.
Notes	Sources of funding: The National Council for Research and Development in Lebanon Conflicts of interest: not reported.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	"They were randomly assigned to the groups of comparison: patients with odd admission number were assigned to the experimental group, while patients with pair admission number were assigned to the control group." (p. 113)

Deyirmenjian 2006 (*Continued*)

Allocation concealment (selection bias)	High risk	Allocation based on admission numbers.
Blinding of medical personnel (performance bias)	Unclear risk	Not described.
Blinding of outcome assessment (detection bias) Observer-reported outcomes	Low risk	Time to extubation: "Nurses collected data related to measurements of [...] time to extubation. The nurses were not aware whether the patient belonged to the experimental or control group" (p.114)
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Self-reported outcomes.
Incomplete outcome data (attrition bias) short-term	Low risk	No missing data.
Selective reporting (reporting bias)	Unclear risk	No discrepancies between outcomes listed in the methods section and outcomes reported in the results section of the trial, however, study protocol was not available to compare outcomes of the protocol and reported outcomes

Gilliss 1993

Methods	Randomised controlled trial. Study duration: not reported. Date study was conducted: not reported.
Participants	*Setting* 2 hospitals in the western United States (large community hospital with an active cardiovascular surgery practice, health sciences research centre) *Inclusion criteria* Age between 25 and 75 years. Coronary artery bypass surgery (CABG), CABG and valve replacement or repair, valve replacement or repair, double valve replacement or repair, septal repair, or repeats of any of these procedures. Conversant in English. Available for telephone follow-up for 6 months after surgery With a primary caregiver also available for 6 months follow-up and consenting to participate. *Exclusion criteria* Aneurysms, aortic arch repairs, chronic ventricular arrhythmia, automatic implantable cardioverter defibrillator, or idiopathic hypertrophic subaortic stenosis *Baseline data*

	N = 156 (intervention 75, control 81). Coronary artery bypass surgery: intervention 61%; control 63%, valve surgery: intervention 31%; control 26%, CABG + valve: intervention 5%; control 7%, other: intervention 3%; control 4% Male gender: intervention 81%; control 79%. Mean age: intervention 59 years; control 60 years. NYHA III+IV: intervention 41%; control 49%.
Interventions	*Routine care for all participants* In-hospital screening by individual participants of slide-tape programmes from the American Heart Association series, *An Active Partnership*, and a post hospital visit at 6 weeks to the cardiac surgeon *Control group* Routine care (TAU). *Intervention group* Psychoeducation, cognitive-behavioural intervention. Intervention I: postoperative in-hospital education (typically 2 days after discharge from the ICU) for participants and partners on emotional reactions to surgery; slide-tape presentation *Working Together for Recovery* addressing: understanding anxiety, anticipating depression, solving new problems, identifying areas of potential conflict with family members, identifying common feelings and reactions of participants and partners, offering basic information on conflict resolution; following education by a private session with a study nurse for individualisation of the content Intervention II: telephone contact on a weekly basis through the 1st 4 weeks after discharge and again at 6 and 8 weeks; provision of frequent and individualised support, reinforcement of the educational content of intervention I, provision of information for formation of self-efficacy expectations
Outcomes	*Postoperative mental distress* Psychological distress/psychological functioning. Profile of Mood States (POMS, McNair 1971) - total score. Continuous measure (sum of 65 items measured on 5-point scale; higher scores indicated greater distress) Participant-reported. 3rd interval (4 weeks after surgery, 12 weeks after surgery, 24 weeks after surgery) *Postoperative levels of mobility* Walking. Activity checklist (Jenkins 1985), walking items. Continuous measure (yes/no; number of completed activities in the previous 24-hour period; higher scores indicated greater ambulation) Participant-reported. 3rd interval (4 weeks after surgery, 8 weeks after surgery, 12 weeks after surgery, 24 weeks after surgery) *Postoperative levels of mobility* Lifting. Activity checklist (Jenkins 1985), lifting items.

Gilliss 1993 (*Continued*)

	Continuous measure (yes/no; number of completed activities in the previous 24-hour period; higher scores indicated greater ambulation) Participant-reported. 3rd interval (4 weeks after surgery, 8 weeks after surgery, 12 weeks after surgery, 24 weeks after surgery) *Postoperative levels of mobility* Climbing. Activity checklist (Jenkins 1985), climbing items. Continuous measure (yes/no; number of completed activities in the previous 24-hour period; higher scores indicated greater ambulation) Participant-reported. 3rd interval (4 weeks after surgery, 8 weeks after surgery, 12 weeks after surgery, 24 weeks after surgery) *Postoperative levels of mobility* General activity. Activity checklist (Jenkins 1985), general activity items. Continuous measure (yes/no; number of completed activities in the previous 24-hour period; higher scores indicated greater ambulation) Participant-reported. 3rd interval (4 weeks after surgery, 8 weeks after surgery, 12 weeks after surgery, 24 weeks after surgery) No adverse events reported.
Notes	Sources of funding: grant from the National Center for Nursing Research, National Institutes of Health, U.S. Department of Health and Human Services (2RO1-NR-01031) Conflicts of interest: not reported.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"A cluster-randomized control design was used […] Clusters, stratified by hospital, were randomized to be either experimental or control by use of a computer program for generating random numbers." (p. 127)
Allocation concealment (selection bias)	Low risk	"The random assignment of the cluster was not disclosed until a patient in the cluster had reached the point where the experimental intervention differed from the control." (p. 127)
Blinding of medical personnel (performance bias)	Unclear risk	Not described.

Gilliss 1993 (*Continued*)

Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported outcome.
Incomplete outcome data (attrition bias) short-term	Low risk	"intent to treat" analyses were conducted (p. 129).
Selective reporting (reporting bias)	Unclear risk	No discrepancies between outcomes listed in the methods section and outcomes reported in the results section of the trial, however, study protocol was not available to compare outcomes of the protocol and reported outcomes

Guo 2012

Methods	Randomised controlled trial. Study duration: 15 months. Date study was conducted: 1st December 2009 to 17th March 2010
Participants	*Setting* Cardiac surgery wards of two public hospitals in Luoyang, China *Inclusion criteria* 18 years or older. First-time elective cardiac surgery (coronary artery bypass grafting, valve surgery, congenital and other open heart surgery) Able to speak, read, and write Chinese. *Exclusion criteria* Emergency cases. Participants who had undergone cardiac surgery on a previous occasion *Baseline data* N = 153 (intervention 76, control 77). Coronary artery bypass surgery: intervention 49%; control 43%, valve surgery: intervention 32%; control 36%; congenital surgery or others: intervention 20%; control 21% Male gender: intervention 58%; control 52%. Mean age: intervention 52 years; control 52.3 years. Married: intervention 78%; control 86%. Education > 9 years: intervention 26%; control 27%. Employment: intervention 21%; control 25%.
Interventions	*Routine care for all participants* Unstructured verbal information about surgery and anaesthesia, 2 separate visits from surgeon and anaesthetist, responsive information from cardiac nurses on the ward, 1 day before surgery *Control group* Routine care (TAU).

Guo 2012 (*Continued*)

	Intervention group Psychoeducation. Distribution of information leaflet *Your Heart Surgery* (simple texts and diagrams); provision of 15 to 20 min verbal advice by specialist cardiac nurse; specifically tailored procedural and instructional information throughout cardiac surgery participants´ journey from admission to hospital discharge 2 to 3 days before surgery.
Outcomes	*Postoperative mental distress* Anxiety. Hospital Anxiety and Depression Scale (HADS, Chinese-Cantonese version, Leung 1999), anxiety subscale. Continuous measure (sum of 7 items measured on 4-point scale, scores ranged from 0 to 21; higher scores indicated greater anxiety) Participant-reported. 2nd interval (7 days after surgery). *Postoperative mental distress* Depression. Hospital Anxiety and Depression Scale (HADS, Chinese-Cantonese version, Leung 1999), depression subscale. Continuous measure (sum of 7 items measured on 4-point scale, scores ranged from 0 to 21; higher scores indicated greater depression) Participant-reported. 2nd interval (7 days after surgery). *Postoperative pain intensity* Average pain. Brief Pain Inventory-short form, pain severity item for average pain (BPI-C, Chinese version; Wang 1996). Continuous measure (10 cm visual analogue scale; higher scores indicated greater pain) Participant-reported. 2nd interval (7 days after surgery). *Postoperative pain intensity* Current pain. Brief Pain Inventory-short form, pain severity item for current pain (BPI-C, Chinese version; Wang 1996). Continuous measure (10 cm visual analogue scale; higher scores indicated greater pain) Participant-reported. 2nd interval (7 days after surgery). No adverse events reported.
Notes	Sources of funding: PhD studentship by the School of Nursing, Midwifery and Physiotherapy, the University of Nottingham No conflict of interest declared by the authors.
Risk of bias	

Guo 2012 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"The randomizations list was prepared by AA using the 'ralloc' command in Stata version 9.2" (p.131)
Allocation concealment (selection bias)	Low risk	"Randomization was implemented by PG using a series of consecutively numbered, opaque, sealed envelopes. The envelope was opened in the presence of the participant after baseline assessment was completed." (p.131)
Blinding of medical personnel (performance bias)	Low risk	"Participants in the preoperative education group were asked not to inform clinical staff about their allocation during the trial." (p. 131)
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported outcome.
Incomplete outcome data (attrition bias) short-term	Low risk	Missing outcome data balanced in numbers and similar reasons for missing data across groups
Selective reporting (reporting bias)	Low risk	Study protocol was available (www.controlled-trials.com/ISRCTN87451169)

Heilmann 2016

Methods	Randomised controlled trial. Date study was conducted: April 2010 to January 2012.
Participants	*Setting* Department of Cardiovascular Surgery, Heart Center, University of Freiburg, Germany *Inclusion criteria* Scheduled for elective first coronary artery bypass grafting, also combined with valve surgery and or MAZE Aged over 18 years. Able to communicate (knowledge of the German language, comprehension of the study) Able to give written consent. *Exclusion criteria* Severe physical and/or mental burden due to illness (Karnofsky index < 20) *Baseline data* N = 253 (intervention 139, control 114). Male gender: intervention 79.1%; control 86.6%.

Heilmann 2016 (*Continued*)

	Mean age: intervention 69 years; control 67.5 years. Married: intervention 74.1%; control 71.9%. Education: secondary school (9 years): intervention 61.8%, control 67.6%; junior high school (10 years): intervention 18.3%, control 13.5%; high school (13 years): intervention 14.5%, control 9.9%; university degree: 5.3%, control 9,0% NYHA: intervention 0.8%; control 0.8%.
Interventions	*Routine care for all participants* Usual preoperative and postoperative care including information about surgery, anaesthesia, and the hospital stay in general *Control group* Routine care (TAU). *Intervention group* Psychoeducation, relaxation. 30 minutes open dialogue with additional information regarding surgery, postoperative care, and emotional support by a trained nurse, centred on the specific fears reported by the participant Intervention was based on a manual which was developed for this study by analysing semi-structured interviews (focused on issues related to fear and anxiety in scheduled CABG participants) Short relaxation exercises using positive imagination directed to the time after surgery
Outcomes	*Postoperative mental distress* Affective anxiety. State-Trait Operation Anxiety (STOA, Krohne 2005), STOA-S subscale. Continuous measure (sum of 5 items for each component of state anxiety, each item can be ranked: almost never, sometimes, often, almost always) Participant-reported. 2nd interval (5 days postoperatively). *Postoperative mental distress* Cognitive anxiety. State-Trait Operation Anxiety (STOA, Krohne 2005), STOA-S subscale. Continuous measure (sum of 5 items for each component of state anxiety, each item can be ranked: almost never, sometimes, often, almost always) Participant-reported. 2nd interval (5 days postoperatively). *Postoperative mental distress* Anxiety. Visual Analogue Scale (VAS). Continous measure (ranging from “no fear” to “very high fear”) Participant-reported. 2nd interval (5 days postoperatively).
Notes	Sources of funding: “German Heart Research Foundation by a research grant to Matthias Siepe” (co-author) p. 360 No conflict of interest declared by the authors.
Risk of bias	

Heilmann 2016 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"A computerised randomisation was employed." (p.354).
Allocation concealment (selection bias)	Low risk	"Assignment to the groups was done by a programme based on index numbers on the mail server." (p. 354-5)
Blinding of medical personnel (performance bias)	High risk	"The attending health care team was not blinded to the group assignment." (p. 353)
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported outcomes.
Incomplete outcome data (attrition bias) short-term	Low risk	Missing outcome data balanced in numbers and similar reasons for missing data across groups N = 21 participants in intervention group and N = 25 participants in control group were lost to follow up. Reason for lost to follow-up: "inaccessibility of the patient due to medical reason" p. 356 "Data analysis was conducted as an intention-to-treat-analysis" p. 355
Selective reporting (reporting bias)	Low risk	Study protocol available (German Clinical Trials Register Identifier: DRKS00000696; Clinical Trials Register of the Medical Center, University of Freiburg Identifier: UFK001262)

Hoseini 2013

Methods	Randomised controlled trial. Date study was conducted: not reported.
Participants	*Setting* Two hospitals in Shiraz. *Inclusion criteria* No history of CABG surgery. Full understanding of Persian language. Willingness to participate in the research. < 75 years. Having facilities for using audiotape. *Exclusion criteria*

Hoseini 2013 (*Continued*)

	Hearing loss. Dementia, confusion, mental and psychological problems. *Baseline data* N = 70 (intervention 35, control 35). Mean age: intervention 60.86 years; control 59.77 years.
Interventions	*Routine care for all participants* Not described. *Control group* Routine care. *Intervention group* Psychoeducation. Audiotape educational program. In addition to routine training. Audiotape contained all the training and information needed for postoperative care at home After the surgery (before discharge).
Outcomes	*Postoperative mental distress* Anxiety. Hospital Anxiety and Depression Scale (HADS, Zigmond 1983), anxiety subscale. Continuous measure (sum of 7 items measured on 3-point scale, scores ranged from 0 to 21; higher scores indicated greater anxiety) Participant-reported. 3rd interval (6 weeks after the intervention). *Postoperative mental distress* Depression. Hospital Anxiety and Depression Scale (HADS, Zigmond 1983), depression subscale. Continuous measure (sum of 7 items measured on 3-point scale, scores ranged from 0 to 21; higher scores indicated greater depression) Participant-reported. 3rd interval (6 weeks after the intervention).
Notes	Sources of funding: Shiraz University of Medical Sciences. Conflicts of interest: not reported.

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Not described.
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding of medical personnel (performance bias)	Unclear risk	Not described.

Hoseini 2013 (*Continued*)

Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported.
Incomplete outcome data (attrition bias) short-term	Low risk	No missing data.
Selective reporting (reporting bias)	Low risk	Study protocol available (Iranian Registry of Clinical Trials Identifier: IRCT138902183872N2)

Ku 2002

Methods	Randomised controlled trial. Study duration: not reported. Date study was conducted: not reported.
Participants	*Setting* Taipei Veterans General Hospital, Taiwan. *Inclusion criteria* Older than 40 years. Elective coronary artery bypass surgery. Able to understand Mandarin and/or Taiwanese, able to read Chinese or with interpreter *Exclusion criteria* Previous open heart surgery. Known neurologic problem. *Baseline data* N = 60 (intervention 30, control 30). Male gender: 83% (intervention 87%; control 80%). Mean age: intervention 68.5 years; control 69 years. Married: intervention 97%; control 80%. Education ≥ 12 years: both groups 47%. Employed: intervention 10%; control 13%.
Interventions	*Routine care for all participants* Regular preoperative nursing care 1 day before surgery by the ward nurse *Attention control group* Daily social visit by the researcher (10 mins every afternoon) during hospitalisation; researcher was recording exercises and daily activities *Intervention group* Psychoeducation. Phase I cardiac rehabilitation Chinese manual. Brochure with illustrations of indications and contraindications of cardiac rehabilitation, general principles of exercise prescription, exercise programmes; daily activities programme given to the participants preoperatively; researcher discussed participant´ s con-

Ku 2002 (*Continued*)

	cerns and questions, and recorded exercises and daily activities, 15 mins every afternoon during hospitalisation
Outcomes	*Postoperative mental distress* Anxiety. State-Trait Anxiety Inventory (STAI, Chinese version), state anxiety score Continuous measure (score ranged from 20 to 80; higher scores indicated higher anxiety) Participant-reported. 2nd interval (at discharge). No adverse events reported.
Notes	Sources of funding: not reported. Conflicts of interest: not reported.

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	High risk	"Subjects were randomly assigned" (p. 135) , "A quasi-experimental study design was used" (p.134)
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding of medical personnel (performance bias)	Unclear risk	Not described.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported outcome.
Incomplete outcome data (attrition bias) short-term	Unclear risk	Not described.
Selective reporting (reporting bias)	Unclear risk	No discrepancies between outcomes listed in the methods section and outcomes reported in the results section of the trial, however, study protocol was not available to compare outcomes of the protocol and reported outcomes

Mahler 1998

Methods	Randomised controlled trial. Study duration: not reported. Date study was conducted: not reported.
Participants	*Setting* Scripps Memorial Hospital and San Diego Veterans Affairs Center in La Jolla, California, USA *Inclusion criteria* First time, nonemergency coronary artery bypass surgery without associated procedures (e.g. valve surgery) Male gender. English speaking. *Exclusion criteria* Serious medical problems (e.g. terminal cancer). *Baseline data* N = 258 (no information about initial distribution across groups) Coronary artery bypass surgery (mean number of grafts: 3.8; ejection fraction: 57%) Male gender: 100%. Mean age: 62.5 years. Married: 75%. Education: 13.5 years.
Interventions	*Routine care for all participants* Standard discharge preparation, consisting almost exclusively of procedural information (e.g. basic information regarding how the surgery is performed, length of typical stay in the ICU and hospital) and instructions regarding performance of recovery behaviours (e.g. deep breathing and coughing, ambulation), orally provided by a nurse or by commercially-prepared videotapes (e.g. 5-min video how to use the incentive spirometer) *Control group* Routine care (TAU). *Intervention groups* Group A: psychoeducation. "Mastery tape" provides excerpts of interviews with 3 male CABG participants the day prior to surgery and several days after surgery; videotaped participants were discussing their own experiences/feelings and were not coached; participants were depicted as relatively calm preoperatively and as overcoming difficulties of surgery rather easily by making steady progress postoperatively; video was provided on the evening prior to surgery Group B: psychoeducation. "Coping tape" provides excerpts of interviews with 3 male CABG participants the day prior to surgery and several days after surgery; videotaped participants were discussing their own experiences/feelings and were not coached; participants were depicted as coping effortfully but successfully with a variety of postoperative difficulties; was provided on the evening prior to surgery Group C: psychoeducation. "Nurse tape" features only narration and demonstrations by a cardiothoracic nurse spe-

	cialist; was provided on the evening prior to surgery
Outcomes	*Postoperative levels of mobility* Postoperative ambulation. Integrated Motor Activity Monitor counting movements by means of a miniature mercury switch that is sensitive to 10° of tilt off horizontal, worn for an average of 7.55 hours each recording day Continuous measure (counted movements; higher scores indicated greater ambulation) Observer-reported. 2nd interval (2nd to 5th postoperative day). No adverse events reported.
Notes	Sources of funding: grants by the American Heart Association and the National Heart, Lung, and Blood Institute Conflicts of interest.: not reported.

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Author: "In order to randomize participants to condition, one of the principal investigators (who was not involved in recruiting participants) utilized a block randomizations procedure (block sizes of 20). " and "A random numbers table was used to generate the randomizations sequence."
Allocation concealment (selection bias)	Low risk	Not described in the paper. Author: "Condition assignment was concealed from researchers in consecutively numbered, sealed envelopes. Once a participant had been enrolled and initial measures/questionnaires were completed, the researcher opened the envelope to reveal the condition letter (A, B, C, or control). The envelopes were opaque and the paper inside was folded so that there was no way for the researcher to see the condition until opening the sealed envelope."
Blinding of medical personnel (performance bias)	Unclear risk	Not described.
Blinding of outcome assessment (detection bias) Observer-reported outcomes	Unclear risk	Mobility: no information about blinding of outcome assessors

Mahler 1998 (*Continued*)

Incomplete outcome data (attrition bias) short-term	Low risk	Author: "Four participants were lost from the Coping tape condition, 2 were lost from the Mastery Tape condition, 3 were lost from the Nurse Tape condition, and 1 was lost from the control condition (none withdrew from the study - all were lost due to serious medical complications, e.g. death during surgery, debilitating stroke during the perioperative period)"
Selective reporting (reporting bias)	Unclear risk	No discrepancies between outcomes listed in the methods section and outcomes reported in the results section of the trial, however, study protocol was not available to compare outcomes of the protocol and reported outcomes

Mahler 1999

Methods	Randomised controlled trial. Study duration: not reported. Date study was conducted: not reported.
Participants	*Setting* Scripps Memorial Hospital and San Diego Veterans Affairs Centerin La Jolla, California, USA *Inclusion criteria* First-time, nonemergency coronary artery bypass surgery. *Exclusion criteria* Not described. *Baseline data* N = 215 (intervention A (mastery tape) 65, intervention B (coping tape) 75, control 75) Coronary artery bypass surgery (mean number of grafts: 4, ejection fraction: 53%) Male gender: 86.5%. Mean age: 61.4 years. Married: 82%. Education: 14.2 years.
Interventions	*Routine care for all participants* Standard discharge preparation. *Control group* Routine care (TAU). *Intervention groups* Group A: psychoeducation. "Mastery tape" providing accurate procedural information (e.g. instructions regarding lifting, exercise, diet, incision care, resumption of normal activities, when to get medical

	attention) and sensory information (e.g. levels of pain and fatigue common at various points after surgery, common emotions, sleep and appetite changes), narration by cardiothoracic nurse specialist, videotaped participants, not coached, depicted as calm and confident at the time of release, as making steady progress with no mention of complications during 6 months after surgery, as adjusting to the recommended exercise and low-fat diet with relative ease; was provided on the evening prior to surgery Group B: psychoeducation. "Coping tape" providing accurate procedural information and sensory information (see A for details), narration by cardiothoracic nurse specialist, videotaped participants, not coached, mention concerns they are experiencing about hospital release and cope with effort but successful with a variety of difficulties (e.g. heart rhythm disturbances, fatigue, diet changes); was provided on the evening prior to surgery
Outcomes	*Postoperative mental distress* Anxiety. Positive and Negative Affect Schedule (PANAS, Watson 1988), anxiety items. Continuous measure (average of 6 items measured on 5-point scale; higher scores indicated greater anxiety) Participant-reported. 2nd interval (at discharge). 3rd interval (1 month after discharge/3 months after discharge) No adverse events reported.
Notes	Sources of funding: grant by the National Heart, Lung, and Blood Institute Conflicts of interest: not reported.

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Not described.
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding of medical personnel (performance bias)	Unclear risk	Not described.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported outcome.
Incomplete outcome data (attrition bias) short-term	High risk	Imbalance in numbers for missing data across intervention groups, no reasons for missing data stated

Mahler 1999 (*Continued*)

Selective reporting (reporting bias)	Unclear risk	No discrepancies between outcomes listed in the methods section and outcomes reported in the results section of the trial, however, study protocol was not available to compare outcomes of the protocol and reported outcomes

Martorella 2012

Methods	Randomised controlled trial. Study duration: 4 months. Date study was conducted: February 2010 to June 2010.
Participants	*Setting* Cardiac surgery unit, Hospital Centre of the University of Montreal, Canada *Inclusion criteria* 18 years and older. First intention cardiac surgery involving sternotomy (coronary artery bypass surgery, valve replacement, or both procedures) Able to understand and complete questionnaires in French. *Exclusion criteria* Previous cardiac surgery. Participants planned to be on a postoperative epidural protocol Unable to consent because of a cognitive or psychiatric disorder *Baseline data* N = 60 (intervention 30, control 30). Coronary artery bypass surgery 60%, valve replacement 17%, both procedures 21% (mean number of grafts: intervention 3.3; control 2.5) Male gender: intervention 80%; control 77%. Mean age: intervention 64.6 years; control 63.2 years. Married: intervention 70%; control 64%. High school education or university: intervention 45%; control 53% Working (full time/part time): intervention 45%; control 47%
Interventions	*Routine care for all participants* Pamphlet describing general principles of pain management. *Control group* Routine care (TAU). *Intervention group* Psychoeducation. SOULAGE-TAVIE web application (French version of self-management support-treatment-virtual nursing assistance and education) One day/few days before surgery: 30-min tailored preoperative session on laptop animated by a virtual nurse that guided the participant through a learning process about management of pain; 2nd and 3rd postoperative day: 5 to 10-min tailored reinforcements with principal investigator

Outcomes	*Postoperative mental distress* Anxiety. Hospital Anxiety and Depression Scale (HADS, Zigmond 1983) - anxiety subscale. Continuous measure (higher scores indicated higher anxiety). Participant-reported. 2nd interval (day 7 after surgery). *Postoperative mental distress* Depression. Hospital Anxiety and Depression Scale (HADS, Zigmond 1983) - depression subscale. Continuous measure (higher scores indicated higher depression) Participant-reported. 2nd interval (day 7 after surgery). *Postoperative pain intensity* Present pain. Numeric rating scale (NRS). Continuous measure (0 = no pain at all, 10 = worst possible pain) Participant-reported. 1st interval (24-hour postoperatively/48-hour postoperatively) 2nd interval (day 7 after surgery). *Postoperative pain intensity* Average pain upon last 24 hours. Numeric rating scale (NRS). Continuous measure (0 = no pain at all, 10 = worst possible pain) Participant-reported. 1st interval (24-hour postoperatively/48-hour postoperatively) 2nd interval (day 7 after surgery). *Postoperative pain intensity* Worst pain upon last 24 hours. Numeric rating scale (NRS). Continuous measure (0 = no pain at all, 10 = worst possible pain) Participant-reported. 1st interval (24h postoperatively/48h postoperatively). 2nd interval (day 7 after surgery). *Postoperative pain intensity* Present pain at rest. Numeric rating scale (NRS). Continuous measure (0 = no pain at all, 10 = worst possible pain) Participant-reported. 1st interval (24h postoperatively/48h postoperatively). 2nd interval (day 7 after surgery). *Postoperative analgesic use (PCA)* Opioid dose (morphine equivalents).

	Continous measure (higher levels indicated higher dose). Observer-reported. 1st interval (24-hour postoperatively/48-hour postoperatively) 2nd interval (day 7 after surgery). No adverse events reported.
Notes	Sources of funding: grants from the Quebec Interuniversity Nursing Intervention Research Group (Groupe de recherche interuniversitaire sur les interventions en sciences infirmières du Québec; GRIISIQ), the Canadian Nurses Foundation (CNF), and the Chair for Research Into New Practices in Nursing of the CHUM which is held by Dr José Côté. doctoral fellowship from Canadian Institutes of Health Research (CIHR) No conflict of interest declared by the authors.

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	"Permuted-block randomizations with allocation ratio of 4 was used to generate a list through computer software" (p.7 of manuscript retrieved by study author)
Allocation concealment (selection bias)	Low risk	"The randomized allocation through the use of concealed envelopes was also clarified." (p.7)
Blinding of medical personnel (performance bias)	Low risk	"Clinical staff was blinded to group allocation." (p.8).
Blinding of outcome assessment (detection bias) Observer-reported outcomes	Low risk	Postoperative analgesic use (PCA): "medical records that were examined by a trained nurse who was also blinded to group allocation" (p.7)
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Self-reported outcomes.
Incomplete outcome data (attrition bias) short-term	Low risk	"The protocol privileged an intention-to-treat approach for the analysis of results" (p.17)
Selective reporting (reporting bias)	Low risk	Study protocol available (ClinicalTrials.gov Identifier:NCT01084018)

Moore 2001

Methods	Randomised controlled trial. Study duration: not reported. Date study was conducted: not reported.
Participants	*Setting* Cardiac unit at an 800-bed acute-care urban teaching hospital in Cleveland, Ohio, USA *Inclusion criteria* Having had first coronary artery bypass surgery within the last 4 or 5 days Being cognitively intact. Being able to speak, read, and write English. Residing within a 90-mile radius of Cleveland. Being discharged to one´ s home. *Exclusion criteria* Having major complications from surgery. *Baseline data* N = 180 (intervention 90, control 90). Coronary artery bypass surgery (mean number of grafts intervention: 3.3; control: 3.5) Male gender: 53%. Mean age: intervention 62 years; control 63 years. Married: intervention 71%; control 62%. Education: intervention 12.8 years; control 13.5 years. Employed: intervention 51%; control 41%. NYHA III + IV: intervention 42%; control 41%.
Interventions	*Routine care for all participants* Usual discharge instructions provided by unit nurses consisting of information about cardiac physiology, risk factor modification, activity, diet guidelines, medications, and general recovery information in form of videotapes, pamphlets, and one-to-one counselling *Control group* Routine care (TAU). *Intervention group* Psychoeducation. Cardiac Home Information Program (CHIP, Moore 1994). 15-min audiotaped message with a professional female voice, describes typical recovery experiences of CABG participants, participants listened once at hospital (4th/5th postoperative day) under observation of research assistant, encouraged to listen to the audiotape as many times as they felt necessary at hospital and at home
Outcomes	*Postoperative mental distress* Psychological distress/psychological functioning. Profile of Mood States (POMS, McNair 1971) - total score. Continuous measure (sum of 43 items measured on 5-point scale ranging from 1 = not at all to 5 = extremely; higher scores indicated greater distress) Participant-reported. 3rd interval (1 month after discharge). No adverse events reported.

Moore 2001 (*Continued*)

Notes	Sources of funding: American Heart Association (grant number: 96009410) Conflicts of interest: not reported.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Table of random numbers was used, p. 98.
Allocation concealment (selection bias)	Unclear risk	"A sealed envelope indicating group assignment (determined using a table of random numbers) was opened by the RA" (p. 98); unclear if envelopes were sequentially numbered and opaque
Blinding of medical personnel (performance bias)	Unclear risk	Not described.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported outcome.
Incomplete outcome data (attrition bias) short-term	Low risk	Numbers of participants who did not complete and reasons stated, numbers of participants who dropped out equally distributed between intervention and control groups
Selective reporting (reporting bias)	Unclear risk	No discrepancies between outcomes listed in the methods section and outcomes reported in the results section of the trial, however, study protocol was not available to compare outcomes of the protocol and reported outcomes

Parent 2000

Methods	Randomised controlled trial. Study duration: 4 months. Date study was conducted: June 2004 to September 2004.
Participants	*Setting* Montreal Heart Institute, Quebec, Canada. *Inclusion criteria* Age 40 to 69 years. First-time elective coronary artery bypass surgery. Male gender.

Parent 2000 (*Continued*)

	Exclusion criteria Valve dysfunction, signs or symptoms of unstable arrhythmias or heart failure History of or treatment for psychiatric illness. *Baseline data* N = 67 (intervention 36, control 31). Coronary artery bypass surgery (median number of grafts: 3). Male gender: 100%. Mean age: intervention 57.6 years; control 55.9 years. Previous myocardial infarction: intervention 37%; control 36%
Interventions	*Routine care for all participants* Routine information on surgery and recovery by health professionals *Control group* Routine care (TAU). *Intervention group* Psychoeducation. One-on-one support intervention, 3 supporting visits by a volunteer former patient (trained), providing vicarious experience, emotional and informational support to reassure participants, coach them toward activity, and reinforce risk factor reduction; supportive acts included listening, responding to concerns, affirmation, feedback, and social comparisons; interventions were tailored to the participant′ s needs 24 hours before surgery, 5th postoperative day, 4 weeks after surgery
Outcomes	*Postoperative mental distress* Anxiety. State Trait Anxiety Inventory (STAI, French version, Bergeron 1976) - state anxiety. Continuous measure (20 items; total scores ranging from 20 to 80; higher scores indicated greater anxiety) Participant-reported. 3rd interval (5th postoperative day, 4 weeks after discharge). *Postoperative levels of mobility* Walking. Jenkins Activity Checklist (Jenkins 1989) - subscale walking. Continuous measure (3-point scale checklist, ratings of yes/no/not applicable, for carrying out each physical activity in the previous 24 hours, total score by summing up number of yes-responses; scale ranged from 0 to 14 for walking; higher scores indicated higher reported performance of activity) Participant-reported. 3rd interval (5th postoperative day, 4 weeks after discharge) *Postoperative levels of mobility* Climbing. Jenkins Activity Checklist (Jenkins 1989) - subscale climbing. Continuous measure (3-point scale checklist, ratings of yes/no/not applicable, for carrying out each physical activity in the previous 24 hours, total score by summing up number of yes-responses; scale ranged from 0 to 7 for climbing; higher scores indicated higher reported performance of activity)

Parent 2000 (*Continued*)

	Participant-reported. 3rd interval (5th postoperative day, 4 weeks after discharge) *Postoperative levels of mobility* General activities. Jenkins Activity Checklist (Jenkins 1989) - total activity score. Continuous measure (3-point scale checklist, ratings of yes/no/not applicable, for carrying out each physical activity in the previous 24 hours, total score by summing up number of yes-responses; higher scores indicated higher reported performance of activity) Participant-reported. 3rd interval (5th postoperative day, 4 weeks after discharge) No adverse events reported.
Notes	Sources of funding: none. Conflicts of interest: not reported.

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Randomisation by flipping a coin.
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding of medical personnel (performance bias)	Unclear risk	Not described.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported outcome.
Incomplete outcome data (attrition bias) short-term	High risk	Numbers of missing data imbalanced across groups.
Selective reporting (reporting bias)	Unclear risk	No discrepancies between outcomes listed in the methods section and outcomes reported in the results section of the trial, however, study protocol was not available to compare outcomes of the protocol and reported outcomes

Parthum 2006

Methods	Randomised controlled trial. Study duration: 7 months. Date study was conducted: February 2004 to August 2004.
Participants	*Setting* University hospital, Germany. *Inclusion criteria* Older than 18 years. First-time coronary artery bypass surgery (CABG), valve surgery, or combined CABG + valve surgery German participants, conversant in German. *Exclusion criteria* Emergency surgery. Previous heart surgery. Regular pain medication preoperatively. Postoperative intubation longer than 24 hours. Intensive care stay longer than 72 hours after extubation. Psychiatric disorders, dementia, or disorientation. *Baseline data* N = 93 (intervention 45, control 48). No further baseline data described.
Interventions	*Routine care for all participants* Not described. *Control group* Routine care (TAU). *Intervention group* Psychoeducation. Individual preoperative participant education about postoperative pain and pain management (development of postoperative pain, pain perception, consequences, therapy) on the evening before surgery Duration about 20 mins. Participants also received an information leaflet.
Outcomes	*Postoperative pain intensity* Pain during rest retrospective with regard to ICU stay. VAS. Dichotomous measure (number of participants with VAS $\leq$ 3). Participant-reported. 1st interval (36 hours postoperatively). *Postoperative pain intensity* Pain under stress retrospective with regard to ICU stay. VAS. Dichotomous measure (number of participants with VAS $\leq$ 3). Participant-reported. 1st interval (36 hours postoperatively).

	Postoperative pain intensity Present pain during rest. VAS. Dichotomous measure (number of participants with VAS ≤ 3). Participant-reported. 1st interval (36 hours postoperatively). *Postoperative pain intensity* Present pain under stress. VAS. Dichotomous measure (number of participants with VAS ≤ 3). Participant-reported. 1st interval (36 hours postoperatively). No adverse events reported.
Notes	Sources of funding: not reported. No conflict of interest declared by the authors.

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Blockwise randomisation by computer-generated random numbers (p.315)
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding of medical personnel (performance bias)	Unclear risk	Not described.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported outcome.
Incomplete outcome data (attrition bias) short-term	Low risk	Balanced numbers and reasons of missing data across groups.
Selective reporting (reporting bias)	Unclear risk	No discrepancies between outcomes listed in the methods section and outcomes reported in the results section of the trial, however, study protocol was not available to compare outcomes of the protocol and reported outcomes

Pick 1994

Methods	Randomised controlled trial. Study duration: 18 months. Date study was conducted: not reported.
Participants	*Setting* London teaching hospital, UK. *Inclusion criteria* Elective coronary artery bypass surgery. *Exclusion criteria* Surgery in addition to coronary artery bypass. Non-standard anaesthetic technique. *Baseline data* N = 74 (intervention 25, control A (TAU) 24, control B (emotional support) 25) Male gender: intervention 84%; control 88%. Mean age: intervention 58 years; control A 61 years; control B 56 years
Interventions	*Routine care for all participants* Not described. *Control groups* Group A: routine care (TAU). Group B:attention control group. On the day before surgery: participants were visited by the researcher according to the same schedule as the intervention group, were prompted to express their worries and feelings about their hospitalisation and surgery, researcher reflected these concerns, demonstrated that she understood them and accepted them as neutral, emphasised her own concerns for the participant′ s well being; 2 hours after arrival in ICU when awakening from anaesthesia participants were played an audiotape of the researcher′ s voice reassuring them that the operation was complete and that they should simply let the staff do everything to care for them *Intervention group* Relaxation. Visit by researcher on the day before surgery before premedication and twice during first 36 hours postoperatively, each visit lasted about 30 mins, participants were instructed in a relaxation technique based on progressive muscle relaxation, but without instructions for muscle tensing, participants practised breathing through an intubation tube, were encouraged to feel that they would have control over their own ventilation postoperatively, practised using relaxation to facilitate this and to overcome the feelings of discomfort and nausea; 2 hours after arrival in ICU when awakening from anaesthesia audiotape with same instructions played
Outcomes	*Postoperative mental distress* Anxiety. Zung Anxiety and Depression Scale (Zung 1974), subscale anxiety. Continuous measure (higher scores indicated greater anxiety) Participant-reported. 1st interval (1 day after surgery). 3rd interval (30 days after discharge).

Pick 1994 (*Continued*)

	Postoperative mental distress Depression. Zung Anxiety and Depression Scale (Zung 1974), subscale depression. Continuous measure (higher scores indicated greater depression) Participant-reported. 1st interval (1 day after surgery). 3rd interval (30 days after discharge). No adverse events reported.
Notes	Sources of funding: grant from the British Heart Foundation. Conflicts of interest: not reported.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not described.
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding of medical personnel (performance bias)	Unclear risk	Not described.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported outcome.
Incomplete outcome data (attrition bias) short-term	High risk	No reasons for attrition stated, "79% returned completed questionnaires 30 days postoperatively", p. 601
Selective reporting (reporting bias)	Unclear risk	No discrepancies between outcomes listed in the methods section and outcomes reported in the results section of the trial, however, study protocol was not available to compare outcomes of the protocol and reported outcomes

Rief 2017

Methods	Randomised controlled trial. Date study was conducted: April 2011 to May 2015.
Participants	*Setting* Department of Cardiovascular Surgery, Heart Center and the Division of Clinical Psychology, Philipps University Marburg, Germany

	Inclusion criteria Adults older than 18 years. Scheduled for elective on pump CABG or CABG combined with valve surgery Able to give informed consent. Speaking German fluently. *Exclusion criteria* Presence of a serious comorbid noncardiac medical condition or psychiatric condition that substantially affected disability *Baseline data* N = 115 (intervention 74, control: 41). Male gender: intervention 83.75%, control 87.8%. Mean age: intervention 67, control 65. Married: intervention 87.85%, control 80.5%. Education, high school: intervention 27%, control 17.1%. NYHA III: intervention 50%, control 68.3%.
Interventions	*Routine care for all participants* Participants received the standardized informed consent procedure before surgery, and general medical care, but no additional psychological interventions *Control groups* Group A: routine care (TAU). Group B: attention control group (SUPPORT). Routine care for all participants. In addition, in the attention control group (SUPPORT), participants received the same amount of therapist attention like the EXPECT intervention group, but without targeting expectations Therapists encouraged the expressing of emotions and anxieties about the anticipated surgery, and therapists used reflective listening techniques and expressed empathy Participants did not receive audio-CDs. *Intervention group* *Cognitive-behavioural intervention* EXPECT: Intervention focused on the development of realistic expectations about the benefits of surgery and the recovery process Participants were encouraged to develop personal ideas and images about their future after surgery, including plans about activities and how they will enjoy their life afterwards (outcome expectations) Personally relevant steps and plans for the six months after surgery were recorded for participants Participants received a booklet containing all relevant session information, including the work sheets, and audio-CDs of their sessions Normal symptoms after surgery that could be expected were discussed, and differentiated from unlikely complications Participants' control expectations were enhanced by discussing ways how they could manage unpleasant symptoms or sensations, and how they could positively influence the disease course after surgery
Outcomes	*Postoperative mental distress* Anxiety. Hospital Anxiety and Depression Scale (HADS, Herrmann-Lingen 1995).

Rief 2017 (*Continued*)

	Participant-reported. 3rd Interval (6 months after surgery). *Postoperative mental distress* Anxiety. Cardiac Anxiety Questionnaire (CAQ, Eifert 2000). Participant-reported. 3rd interval (6 months after surgery). *Postoperative mental distress* Anxiety. 12-item short-form health survey (12-SF, Ware 1996). Participant-reported. 3rd interval (6 months after surgery). *Postoperative mental distress* Depression. Hospital Anxiety and Depression Scale (Herrmann-Lingen 1995). Observer-reported. 3rd Interval (6 months after surgery). *Postoperative levels of mobility* Physical activity. International Physical Activity Questionnaire (Craig 2003). Observer-reported. 3rd Interval (6 months after surgery).
Notes	Sources of funding: German Research Foundation by a grant to Dr. Rief and Dr. Moosdorf (authors) Conflicts of interest: "The authors are solely responsible for the design and conduct of this study, all study analyses, the drafting and editing of the paper, and its final contents. " p.6

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Assignment to treatment arms followed a stratified permuted block randomizations procedure with a block size of 9. Stratification criteria were age (above or below 65 years) and New York Heart Association (NYHA) class (1,2 versus 3,4) to control for differences in cardiac status. Random procedure was defined using an internet program (WINPEPI) [...]." (p.7)
Allocation concealment (selection bias)	Low risk	"Allocation concealment was verified using closed envelopes including group allocation information that were handed over to the therapist after inclusion of a new patient." (p.7)

Rief 2017 (*Continued*)

Blinding of medical personnel (performance bias)	Low risk	"Surgeons, hospital staff involved in patient care, and staff assessing treatment effects were blind to treatment condition." (p.7)
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported outcome.
Incomplete outcome data (attrition bias) short-term	Low risk	"Thus we started with an ITT sample of 124 patients (87% only CABG; 13% CABG plus heart valve replacement). Follow-up assessments were 6 completed by 108 patients at 6 months follow-up (88.5 % of baseline sample; 87% of ITT sample). Seven patients died post-surgery (2 in SMC, 2 in SUPPORT, 3 in EXPECT condition)." (p.5-6)
Selective reporting (reporting bias)	Low risk	Study protocol available (ClinicalTrials.gov Identifier: NCT01407055)

Shelley 2007

Methods	Randomised controlled trial. Study duration: not reported. Date study was conducted: not reported.
Participants	*Setting* Not described. *Inclusion criteria* First-time coronary artery bypass participants. *Exclusion criteria* Previously received invasive treatments for heart disease. Unable to give legal informed consent. Outside the age range of 30 to 90 years. Received immunization within the past 2 years. Suffered an immune-related disease (such as autoimmune disease, HIV, or hepatitis) Taking hormone replacements. *Baseline data* N = 80 (intervention 37, control 43). Male gender: intervention 59%; control 72%. Mean age: intervention 65.1 years; control 66.1 years.
Interventions	*Routine care for all participants* Not described. *Control group*

	Routine care (TAU). *Intervention group* Psychoeducation, cognitive-behavioural intervention. Preparation designed to aid learning of hospital procedural information and address participant thoughts about how to deal with health-related concerns; four stages: building rapport, participant concerns, question prompts, linking questions with concerns Duration about 30 mins, in the evening of the day before surgery Conducted by research psychologist.
Outcomes	*Postoperative mental distress* Distress. Depression, Anxiety, and Stress Scales (DASS, Lovibond 1995), short form, total score. Continuous measure (sum of 21 items measured on 4-point scale ranging from 0 = did not apply to me at all, to 4 = applied to me very much; higher scores indicated greater distress) Participant-reported. 2nd interval (at discharge). 3rd interval (12 months follow-up after discharge). *Postoperative pain intensity* Present pain. VAS, linear 10-cm scale. Continuous measure (no pain to pain as bad as it could be). Participant-reported. 2nd interval (at discharge). 3rd interval (12 months follow-up after discharge). No adverse events reported.
Notes	12 month follow-up data for distress and pain intensity were provided by Dr. Mike Shelley (personal communication) Sources of funding: grant from the Wesley Research Institute Conflicts of interest: not reported.

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Not described.
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding of medical personnel (performance bias)	Low risk	"the RA administered all inventories, and the data produced and assignments were not revealed to patients, the psychologist, or other hospital staff until the conclusion of the study" (p. 186)

Shelley 2007 (*Continued*)

Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported outcome.
Incomplete outcome data (attrition bias) short-term	Unclear risk	Not described.
Selective reporting (reporting bias)	Unclear risk	No discrepancies between outcomes listed in the methods section and outcomes reported in the results section of the trial, however, study protocol was not available to compare outcomes of the protocol and reported outcomes

Sørlie 2007

Methods	Randomised controlled trial. Study duration: 58 months. Date study was conducted: September 1998 to June 2003.
Participants	*Setting* Department of Cardiothoracic and Vascular Surgery at the University Hospital of North Norway *Inclusion criteria* Age less than 68 years. Stable angina with a planned first-time coronary artery bypass surgery *Exclusion criteria* Severe comorbidity. Severe cognitive impairment. Transferred from other kinds of medical treatment or care. *Baseline data* N = 109 (intervention 55, control 54). Male gender: intervention 89%; control 87%. Mean age: intervention 59 years; control 57.5 years. Married or cohabiting: intervention 91%; control 85%. Education: intervention 9 years; control 8.3 years. Working or at sick leave: intervention 58%; control 54%.
Interventions	*Routine care for all participants* Usual routine hospital pre- and postoperative information. First session at admission: information on a checklist including procedural and sensory information related to the major diagnostic and pre- and postoperative events during hospital stay, some behavioural instructions Second session at hospital discharge: information on preventive life style changes and mastering the situation at home and at work Each session 40 mins duration, carried out by several different nurses *Control group*

Sørlie 2007 (*Continued*)

	Routine care (TAU). *Intervention group* Psychoeducation, cognitive-behavioural intervention. 12-min video viewed at home prior to the hospital admission and during the first information session on admission, illustrated the most important events during hospital treatment and aftercare, presented as a dialogue between a recently discharged patient and a friend, to give some familiarity with the treatment situation and to stimulate curiosity and information-seeking among participants Two information sessions of 40 mins with specially trained nurses; on admission and at hospital discharge, providing relevant information and support to enhance participants´ self regulation and capacity for co-operation with the healthcare professional
Outcomes	*Postoperative mental distress* Anxiety. Beck Anxiety Inventory (BAI, Beck 1988) - total score. Continuous measure (sum of 21 items, score ranged from 21 to 84; higher scores indicated greater anxiety) Participant-reported. 2nd interval (at discharge). 3rd interval (2 weeks after discharge, 6 weeks after discharge, 6 months after discharge, 1 year after discharge, 2 years after discharge) *Postoperative mental distress* Depression. Zung self-rating depression scale (Zung 1965) - total score. Continuous measure (sum of 20 items, score ranged from 20 to 80; higher scores indicated greater depression) Participant-reported. 2nd interval (at discharge). 3rd interval (2 weeks after discharge, 6 weeks after discharge, 6 months after discharge, 1 year after discharge, 2 years after discharge) No adverse events reported.
Notes	Sources of funding: North Norwegian Psychiatric Research Center Conflicts of interest: not reported.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	"Each patient in each block of 20 consecutively consenting patients, were randomly assigned…" (p. 182)
Allocation concealment (selection bias)	Low risk	"Each patient […] were randomly assigned by using opaque, sealed, and sequentially numbered envelopes to either the intervention or the control group status." (p. 182)

Sørlie 2007 (*Continued*)

Blinding of medical personnel (performance bias)	Low risk	"The treating physicians were blinded to the assignment group." (p. 182)
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported outcome.
Incomplete outcome data (attrition bias) short-term	Low risk	"All patients in the study sample (N = 109) were analysed at all timepoints ("last observation carried forward analysis")." (p. 183)
Selective reporting (reporting bias)	Unclear risk	No discrepancies between outcomes listed in the methods section and outcomes reported in the results section of the trial, however, study protocol was not available to compare outcomes of the protocol and reported outcomes

Utriyaprasit 2010

Methods	Randomised controlled trial. Study duration: not reported. Date study was conducted: 2004 to 2005.
Participants	*Setting* Cardiac unit in a tertiary centre in Thailand. *Inclusion criteria* 18 years or older. First coronary artery bypass surgery within the last 8 or 9 days Mentally competent. Literate in Thai language. *Exclusion criteria* Surgery for cardiac valve repair. Major complications from surgery, including cardiac arrest, pulmonary emboli and haemorrhage *Baseline data* N = 120 (intervention 60, control 60). Coronary artery bypass surgery (ejection fraction: intervention 58%; control 65%; mean number of grafts intervention 3.8; control 3.7) Male gender: 70%. Mean age: intervention 62.8 years; control 63.3 years. Married: intervention 83%; control 82%. Education: intervention 7.7 years; control 10.9 years. NYHA III: intervention 17%; control 15%.

Interventions	*Routine care for all participants* Usual cardiac teaching and discharge instructions (before surgery together with relatives: information about the physiology of the heart, CABG procedure, care team, care instructions before and after surgery; day before discharge: information about risk factor modification, activity, diet guidelines, homegoing medication provided by unit nurses) *Attention control group* Visit from researcher on 8th or 9th postoperative day, telephone call 2 weeks and 4 weeks after hospital discharge; general questions about health and well being *Intervention group* Psychoeducation, relaxation. Cardiac Home Information Program, modified Thai version (Thai CHIP) (CHIP: Moore 1994). 30-min audiotaped message with a male voice, containing the expected recovery experiences in sensory and temporal terms and suggestions for coping with them, added by deep breathing relaxation and active progressive relaxation technique, participants listened once at hospital (8th/9th postoperative day) under supervision, encouraged to listen to the audiotape as many times as they felt necessary at hospital and at home
Outcomes	*Postoperative pain intensity* Pain/discomfort. Cardiac Surgery Symptom Inventory (SI, Artinian 1993), subscale shoulder, back or neck pain/discomfort. Continuous measure (scale from 1 to 7 for the frequency of symptoms; higher scores indicated more symptoms) Participant-reported. 2nd interval (at discharge). 3rd interval (2 weeks after discharge, 4 weeks after discharge) *Postoperative levels of mobility* Ambulation. Sickness Impact Profile (SIP, Bergner 1981), physical scale, subscale ambulation. Continuous measure (higher scores indicated greater physical dysfunction) Participant-reported. 2nd interval (at discharge). 3rd interval (2 weeks after discharge, 4 weeks after discharge) *Postoperative levels of mobility* Mobility. Sickness Impact Profile (SIP, Bergner 1981), physical scale, subscale mobility. Continuous measure (higher scores indicated greater physical dysfunction) Participant-reported. 2nd interval (at discharge). 3rd interval (2 weeks after discharge, 4 weeks after discharge) *Postoperative mental distress* Psychological distress/psychological functioning.

Utriyaprasit 2010 (*Continued*)

	Profile of Mood States (POMS, McNair 1971), total score. Continuous measure (sum of 43 items measured on 5-point scale ranging from 0 = not at all, to 4 = extremely; higher scores indicated greater distress) Participant-reported. 2nd interval (at discharge). 3rd interval (2 weeks after discharge, 4 weeks after discharge) No adverse events reported.
Notes	Sources of funding: Thailand Research Fund (grant no.: TRG 4580030) No conflict of interest declared by the authors.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Randomization minimization computer program was used to determine group assignment maintaining group balance in terms of gender, NYHA class and surgeon" (p. 1750)
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding of medical personnel (performance bias)	Unclear risk	Not described.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported outcome.
Incomplete outcome data (attrition bias) short-term	Low risk	Numbers of participants who did not complete reported and reasons stated, numbers of participants who dropped out equally distributed between intervention and control groups
Selective reporting (reporting bias)	Unclear risk	No discrepancies between outcomes listed in the methods section and outcomes reported in the results section of the trial, however, study protocol was not available to compare outcomes of the protocol and reported outcomes

Zarani 2010

Methods	Randomised controlled trial. Study duration: 5 months. Date study was conducted: April 2007 to August 2007.
Participants	*Setting* Teheran Heart Center, Iran. *Inclusion criteria* Age between 40 and 65 years. Coronary artery bypass surgery. Diagnosis of a heart problem for > 1 years. Absence of comorbidities. Ability to read and write. Absence of visual/hearing impairment. Access to medical care. *Exclusion criteria* Not described. *Baseline data* N = 152 (intervention 75, control 77). Male gender: intervention 83%; control 81%. Mean age: 53.2 years. Married: intervention 99%; control 97%. Lower education (high school or less): intervention 75%; control 85%
Interventions	*Routine care for all participants* Not described. *Attention control group* Combination of medical treatment, physician monitoring, and group classes about risk factors for coronary heart disease and self-care behaviours after surgery + supportive counselling. *Intervention group* Psychoeducation, cognitive-behavioural intervention. Preoperative Information-Motivation-Behavioural (IBM) skills model of health behavioural change intervention (Fisher 2003). Information component: participants received information about heart disease risk factors and adherence behaviours using a variety of teaching aids (short educational film, handouts) Motivational component: help for participants to identify, verbalise, and reinforce positive attitudes and behavioural skills deficits by using motivational interview techniques (providing personal feedback, asking open-ended questions, affirmations, reflective listening etc.) to enhance personal and social motivation to adherence to medical recommendations Behavioural skills component: teaching how to effectively monitor nutrition, integrate physical activity into lifestyle, quit smoking, control stress, and to self-administer medications 1 session 120 mins, group intervention (5 participants).

Outcomes	*Postoperative mental distress* Anxiety. Hospital Anxiety and Depression Scale (Iranian version, Montazeri 2003) - anxiety subscale. Continuous measure (sum of 7 items measured on 4-point scale, scores ranged from 0 to 21; higher scores indicated greater anxiety) Participant-reported. 3rd interval (1 month after surgery). *Postoperative mental distress* Depression. Hospital Anxiety and Depression Scale (Iranian version, Montazeri 2003) - depression subscale. Continuous measure (sum of 7 items measured on 4-point scale, scores ranged from 0 to 21; higher scores indicated greater depression) Participant-reported. 3rd interval (1 month after surgery). *Postoperative mental distress* Stress. Perceived Stress Scale (PSS, Cohen 1983). Continuous measure (sum of 10 items measured on 4-point scale, scores ranged from 0 to 40; higher scores indicated greater stress) Participant-reported. 3rd interval (1 month after surgery). No adverse events reported.
Notes	Sources of funding: not reported. No conflict of interest declared by the authors.

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Not described.
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding of medical personnel (performance bias)	Unclear risk	Not described.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported outcome.
Incomplete outcome data (attrition bias) short-term	High risk	Number of missing data balanced, reasons for missing data stated but not separately

Zarani 2010 (*Continued*)

		for groups
Selective reporting (reporting bias)	Unclear risk	No discrepancies between outcomes listed in the methods section and outcomes reported in the results section of the trial, however, study protocol was not available to compare outcomes of the protocol and reported outcomes

Zarea 2014

Methods	Randomised controlled trial. Date study was conducted: 2012 to 2013.
Participants	*Setting* Al-Zahra Heart Hospital, Shiraz, Iran. *Inclusion criteria* Being in a bypass list. Having moderate to severe depression and anxiety scores. No history of mental illness. Interesting in participating in the study. Lack of previous bypass surgery. Aged between 35 and 70 years. Ability to communicate verbally and ability to speak Persian *Exclusion criteria* Lack of cooperation of participants and families during the intervention Failure to perform coronary artery bypass surgery for various reasons Mortality during the study. Failure to attend therapeutic communication sessions (at least the absence in two sessions) *Baseline data* N = 74 (intervention 37, control 37). Male gender: intervention 70.3%; control 48.6%. Age: 51 to 60 years: intervention 91.8%, control 83.7%; 61 to 70 years: intervention 8.2%, control 16.3% Married: intervention 100%; control 100%. Education level: Illiterate: intervention 2.7%, control 0%; primary school: intervention 75.6%, control 70.3%; cycle degree: intervention 16.3%, control 16.3%; high school: intervention 0%, control 5.4%; diploma: intervention 5.4 %, control 8.2%; academic: intervention 0%, control 0%
Interventions	*Routine care for all participants* Not described. *Control group* Routine care. *Intervention group* Psychoeducation. Therapeutic communication sessions. Peplau′ s model at four stages (orientation, identification, exploitation, resolution) Individually seven sessions in content with the participant and his family at the hospital

	and participant′ s home; duration of each session was variable given the location and participant′ s needs; at all meetings researcher used verbal and nonverbal communication skills, therefore, a self-control researcher-made tool approved by experts was used
Outcomes	*Postoperative mental distress* Anxiety. Hospital Anxiety and Depression Scale (Kanter 2007), anxiety subscale. Continuous measure (sum of 7 items measured on 3-point scale, scores ranged from 0 to 21; higher scores indicated greater anxiety) Participant-reported. 3rd interval (2 months after surgery, 4 months after surgery) *Postoperative mental distress* Depression. Hospital Anxiety and Depression Scale (HADS) (Kanter 2007), depression subscale. Continuous measure (sum of 7 items measured on 3-point scale, scores ranged from 0 to 21; higher scores indicated greater depression) Participant-reported. 3rd interval (2 months after surgery, 4 months after surgery)
Notes	Sources of funding: "To write this article not contributed any financial resources and costs are the responsibility of the authors." p.164 Conflicts of interest: "The authors confirm that this article content has no conflict of interest." p.164

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	"The subjects were randomly divided into test and control groups (using a coin (toss))." p. 160
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding of medical personnel (performance bias)	Unclear risk	Not described.
Blinding of outcome assessment (detection bias) Participant-reported outcomes	Unclear risk	Participant-reported.
Incomplete outcome data (attrition bias) short-term	Low risk	No missing data.
Selective reporting (reporting bias)	Low risk	Study protocol available (Iranian Registry of Clinical Trials Identifier: IRCT2013072214110N1)

BAI: Beck Anxiety Inventory
CABG: coronary artery bypass graft surgeries
CAD: coronary artery diagnosis
CBT: cognitive behavioural therapy
cm: centimetre
ICU: intensive care unit
MAZE: a surgical treatment for atrial fibrillation
mins: minutes
N: number of participants
p: page
PCA: participant-controlled analgesia
TAU: treatment as usual

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Anderson 1987	Not randomised.
Ashton 1997	Sample size fewer than 20 participants in each group at first postoperative assessment
Bjornnes 2017	Intervention after discharge.
Blankfield 1995	Particpants were recruited regardless of whether or not the surgery was elective or nonelective
Cacau 2013	No eligible intervention (virtual reality for physiotherapeutic treatment)
Chair 2013	Intervention after discharge.
Cupples 1991	Preadmission intervention (intervention provided before admission to hospital)
Doering 2013	Intervention after discharge.
Fredericks 2013	Sample size < 20 per group.
Hartford 2002	Postdischarge intervention (intervention began on day of discharge and was provided almost exclusively after discharge)
Heidarnia 2005	Not randomised.
Hermele 2005	Preadmission intervention (intervention provided before admission to hospital)
Hojskov 2016	Sample size < 20 per group.
Houston 1999	Sample size fewer than 20 participants in each group at first postoperative assessment
Hwang 1998	Particpants under 18 years of age were recruited.

(*Continued*)

Ikedo 2007	Intervention was not eligible (Hemi-Sync audiotape).
Kalogianni 2016	No eligible intervention (combination of muscle training, physical preparation for operation and techniques for anxiety control)
Keeping-Burke 2013	Intervention after discharge (participants' home).
Kol 2014	No eligible participant group (participants underwent thoracotomy; not only open heart surgeries)
Lamarche 1998	Preadmission intervention (intervention provided before admission to hospital)
Martorella 2014	Not randomised.
Postlethwaite 1986	Sample size fewer than 20 participants in each group at first postoperative assessment
Shamansouri 2013	No eligible outcomes (reducing preoperative anxiety and fear)
Shuldham 2002	Preadmission intervention (intervention provided before admission to hospital)
Sibilitz 2013	No eligible intervention (combination of physical exercise training component and psychoeducational component)
Stein 2010	Sample size fewer than 20 participants in each group at first postoperative assessment
Thoits 2000	Intervention was not eligible (similar or other support: former patients trained in supportive techniques visit the participants and perform minor within-hospital favours for participants)
Watt-Watson 2000	Sample size fewer than 20 participants in each group at first postoperative assessment
Watt-Watson 2004	Preadmission intervention (intervention provided before admission to hospital)
Yin 2011	Open heart surgery participants were not recruited (personal communication)

DATA AND ANALYSES

Comparison 1. Main comparison: Psychological intervention vs control condition

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain intensity measured with continuous scales: short-term	2	104	Hedges ′ g (Random, 95% CI)	0.39 [-0.18, 0.96]
2 Pain intensity measured with continuous scales: medium-term	4	413	Hedges‘ g (Random, 95% CI)	-0.02 [-0.24, 0.20]
3 Pain intensity measured with continuous scales: long-term	2	200	Hedges‘g (Random, 95% CI)	0.05 [-0.20, 0.30]
4 Analgesic use measured via PCA: short-term	2	104	Hedges ′ g (Random, 95% CI)	1.18 [-2.03, 4.39]
5 Mental distress: medium-term	13	1388	Hedges‘ g (Random, 95% CI)	0.37 [0.13, 0.60]
6 Mental distress: long-term	14	1586	Hedges‘ g (Random, 95% CI)	0.32 [0.10, 0.53]
7 Mobility: medium-term	3	444	Hedges‘ g (Random, 95% CI)	0.23 [-0.22, 0.67]
8 Mobility: long-term	4	458	Hedges‘ g (Random, 95% CI)	0.09 [-0.10, 0.28]
9 Time to extubation: short-term	2	154	Hedges ′ g (Random, 95% CI)	0.56 [0.08, 1.03]

Comparison 2. Subgroup analysis: Psychological intervention vs standard care (TAU)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain intensity measured with continuous scales: medium-term	3	293	Hedges ‘ g (Random, 95% CI)	0.09 [-0.11, 0.29]
2 Mental distress: medium-term	11	1208	Hedges‘ g (Random, 95% CI)	0.38 [0.12, 0.64]
3 Mental distress: long-term	12	1224	Hedges‘ g (Random, 95% CI)	0.41 [0.18, 0.65]
4 Mobility: medium-term	2	324	Hedges‘ g (Random, 95% CI)	0.42 [-0.07, 0.91]
5 Mobility: long-term	3	301	Hedges‘ g (Random, 95% CI)	0.26 [-0.10, 0.63]

Comparison 3. Subgroup analysis: Psychological intervention vs attention control group

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Mental distress: medium-term	2	180	Hedges‘ g (Random, 95% CI)	0.34 [-0.53, 1.21]
2 Mental distress: long-term	4	424	Hedges‘ g (Random, 95% CI)	0.01 [-0.21, 0.23]
3 Mobility: long-term	2	194	Hedges′ g (Random, 95% CI)	0.00 [-0.24, 0.24]

Comparison 4. Subgroup analysis: Psychoeducation vs control condition

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Mental distress: medium-term	7	725	Hedges' g (Random, 95% CI)	0.36 [-0.00, 0.72]
2 Mental distress: long-term	5	606	Hedges' g (Random, 95% CI)	0.52 [0.01, 1.02]

Comparison 5. Subgroup analysis: Relaxation vs control condition

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Mental distress: long-term	2	124	Hedges' g (Random, 95% CI)	0.67 [-0.65, 2.00]

Comparison 6. Subgroup analysis: Combined intervention vs control condition

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Mental distress: medium-term	5	613	Hedges' g (Random, 95% CI)	0.24 [-0.07, 0.56]
2 Mental distress: long-term	6	693	Hedges´ g (Random, 95% CI)	0.14 [-0.08, 0.37]

Comparison 7. Sensitivity analysis: Studies with adequate sequence generation

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Mental distress: medium-term	6	704	Hedges' g (Random, 95% CI)	0.48 [0.08, 0.87]
2 Mental distress: long-term	7	771	Hedges' g (Random, 95% CI)	0.27 [0.00, 0.54]

Comparison 8. Sensitivity analysis: Studies with adequate handling of incomplete outcome data

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Mental distress: medium-term	8	916	Hedges' g (Random, 95% CI)	0.23 [0.01, 0.46]
2 Mental distress: long-term	8	920	Hedges' g (Random, 95% CI)	0.28 [0.02, 0.55]

Comparison 9. Sensitivity analysis: Studies with study protocol available

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Mental distress: medium-term	3	420	Hedges' g (Random, 95% CI)	0.23 [-0.10, 0.55]

Analysis 1.1. Comparison 1 Main comparison: Psychological intervention vs control condition, Outcome 1 Pain intensity measured with continuous scales: short-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 1 Main comparison: Psychological intervention vs control condition

Outcome: 1 Pain intensity measured with continuous scales: short-term

Study or subgroup	Intervention N	Control N	Hedges g (SE)	Hedges g IV,Random,95% CI	Weight	Hedges g IV,Random,95% CI
Akgul 2016	22	22	0.68 (0.185)		50.5 %	0.68 [0.32, 1.04]
Martorella 2012	30	30	0.1 (0.194)		49.5 %	0.10 [-0.28, 0.48]
Total (95% CI)	**52**	**52**			**100.0 %**	**0.39 [-0.18, 0.96]**

Heterogeneity: $Tau^2 = 0.13$; $Chi^2 = 4.68$, df = 1 (P = 0.03); $I^2 = 79\%$

Test for overall effect: Z = 1.36 (P = 0.18)

Test for subgroup differences: Not applicable

Analysis 1.2. Comparison 1 Main comparison: Psychological intervention vs control condition, Outcome 2 Pain intensity measured with continuous scales: medium-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 1 Main comparison: Psychological intervention vs control condition

Outcome: 2 Pain intensity measured with continuous scales: medium-term

Study or subgroup	Psychol. Intervention N	Control N	Hedges' g (SE)	Hedges' g IV,Random,95% CI	Weight	Hedges' g IV,Random,95% CI
Guo 2012	76	77	0.1631 (0.1402)		34.2 %	0.16 [-0.11, 0.44]
Martorella 2012	30	30	0.0102 (0.2042)		21.4 %	0.01 [-0.39, 0.41]
Shelley 2007	37	43	0 (0.2182)		19.5 %	0.0 [-0.43, 0.43]
Utriyaprasit 2010	60	60	-0.3271 (0.1826)		24.9 %	-0.33 [-0.68, 0.03]
Total (95% CI)	**203**	**210**			**100.0 %**	**-0.02 [-0.24, 0.20]**

Heterogeneity: $Tau^2 = 0.02$; $Chi^2 = 4.55$, df = 3 (P = 0.21); $I^2 = 34\%$

Test for overall effect: Z = 0.21 (P = 0.83)

Test for subgroup differences: Not applicable

Analysis 1.3. Comparison 1 Main comparison: Psychological intervention vs control condition, Outcome 3 Pain intensity measured with continuous scales: long-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 1 Main comparison: Psychological intervention vs control condition

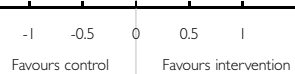
Outcome: 3 Pain intensity measured with continuous scales: long-term

Study or subgroup	Psychol.Intervention N	Control N	Hedges'g (SE)	Hedges'g IV,Random,95% CI	Weight	Hedges'g IV,Random,95% CI
Shelley 2007	37	43	0.0312 (0.2182)		34.5 %	0.03 [-0.40, 0.46]
Utriyaprasit 2010	60	60	0.0564 (0.1582)		65.5 %	0.06 [-0.25, 0.37]
Total (95% CI)	**97**	**103**			**100.0 %**	**0.05 [-0.20, 0.30]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.01$, df = 1 (P = 0.93); $I^2 = 0.0\%$

Test for overall effect: Z = 0.37 (P = 0.71)

Test for subgroup differences: Not applicable



Analysis 1.4. Comparison 1 Main comparison: Psychological intervention vs control condition, Outcome 4 Analgesic use measured via PCA: short-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 1 Main comparison: Psychological intervention vs control condition

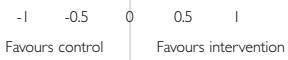
Outcome: 4 Analgesic use measured via PCA: short-term

Study or subgroup	Intervention N	Control N	Hedges g (SE)	Hedges g IV,Random,95% CI	Weight	Hedges g IV,Random,95% CI
Akgul 2016	22	22	2.834 (0.427)		49.4 %	2.83 [2.00, 3.67]
Martorella 2012	30	30	-0.44 (0.226)		50.6 %	-0.44 [-0.88, 0.00]
Total (95% CI)	**52**	**52**			**100.0 %**	**1.18 [-2.03, 4.39]**

Heterogeneity: $Tau^2 = 5.24$; $Chi^2 = 45.92$, df = 1 (P<0.00001); $I^2 = 98\%$

Test for overall effect: Z = 0.72 (P = 0.47)

Test for subgroup differences: Not applicable



Analysis 1.5. Comparison 1 Main comparison: Psychological intervention vs control condition, Outcome 5 Mental distress: medium-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 1 Main comparison: Psychological intervention vs control condition

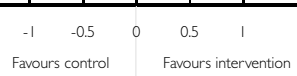
Outcome: 5 Mental distress: medium-term

Study or subgroup	Psychol.intervention N	Control N	Hedges' g (SE)	Hedges' g IV,Random,95% CI	Weight	Hedges' g IV,Random,95% CI
Bergmann 2001	30	30	0.0789 (0.2237)		7.4 %	0.08 [-0.36, 0.52]
Dao 2011	48	49	1.124 (0.236)		7.2 %	1.12 [0.66, 1.59]
De Klerk 2004	25	25	1.152 (0.2451)		7.0 %	1.15 [0.67, 1.63]
Deyirmenjian 2006	57	53	0.0213 (0.1895)		7.9 %	0.02 [-0.35, 0.39]
Guo 2012	76	77	0.5525 (0.1424)		8.7 %	0.55 [0.27, 0.83]
Heilmann 2016	118	89	0.115 (0.081)		9.4 %	0.12 [-0.04, 0.27]
Ku 2002	30	30	0.8024 (0.2652)		6.7 %	0.80 [0.28, 1.32]
Mahler 1999	140	75	-0.127 (0.1694)		8.3 %	-0.13 [-0.46, 0.21]
Martorella 2012	30	30	-0.0411 (0.224)		7.4 %	-0.04 [-0.48, 0.40]
Parent 2000	36	31	1.449 (0.2971)		6.2 %	1.45 [0.87, 2.03]
Shelley 2007	37	43	0 (0.2182)		7.5 %	0.0 [-0.43, 0.43]
S rlie 2007	55	54	0.2014 (0.1664)		8.3 %	0.20 [-0.12, 0.53]
Utriyaprasit 2010	60	60	-0.0859 (0.1815)		8.1 %	-0.09 [-0.44, 0.27]
Total (95% CI)	**742**	**646**			**100.0 %**	**0.37 [0.13, 0.60]**

Heterogeneity: $Tau^2 = 0.15$; $Chi^2 = 68.68$, df = 12 ($P<0.00001$); $I^2 = 83\%$

Test for overall effect: Z = 3.03 (P = 0.0024)

Test for subgroup differences: Not applicable



Analysis 1.6. Comparison 1 Main comparison: Psychological intervention vs control condition, Outcome 6 Mental distress: long-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 1 Main comparison: Psychological intervention vs control condition

Outcome: 6 Mental distress: long-term

Study or subgroup	Psychol.intervention N	Control N	Hedges' g (SE)	Hedges' g IV,Random,95% CI	Weight	Hedges' g IV,Random,95% CI
Dao 2011	48	48	0.481 (0.145)		8.8 %	0.48 [0.20, 0.77]
De Klerk 2004	25	25	1.351 (0.2503)		6.7 %	1.35 [0.86, 1.84]
Gilliss 1993	75	81	0.25 (0.14)		8.9 %	0.25 [-0.02, 0.52]
Hoseini 2013	35	35	3.084 (0.948)		1.2 %	3.08 [1.23, 4.94]
Mahler 1999	140	75	0.18 (0.1694)		8.3 %	0.18 [-0.15, 0.51]
Moore 2001	90	90	-0.0051 (0.1414)		8.8 %	-0.01 [-0.28, 0.27]
Parent 2000	36	31	0.831 (0.2751)		6.3 %	0.83 [0.29, 1.37]
Pick 1994	25	49	0 (0.2259)		7.2 %	0.0 [-0.44, 0.44]
Rief 2017	37	78	0.439947 (0.2316)		7.1 %	0.44 [-0.01, 0.89]
Shelley 2007	37	43	-0.1675 (0.2182)		7.3 %	-0.17 [-0.60, 0.26]
S rlie 2007	55	54	0.3875 (0.1429)		8.8 %	0.39 [0.11, 0.67]
Utriyaprasit 2010	60	60	-0.2672 (0.1587)		8.5 %	-0.27 [-0.58, 0.04]
Zarani 2010	90	90	0.0851 (0.1218)		9.2 %	0.09 [-0.15, 0.32]
Zarea 2014	37	37	0.666 (0.553)		2.8 %	0.67 [-0.42, 1.75]
Total (95% CI)	**790**	**796**			**100.0 %**	**0.32 [0.10, 0.53]**

Heterogeneity: $Tau^2 = 0.12$; $Chi^2 = 58.01$, df = 13 ($P<0.00001$); $I^2 = 78\%$

Test for overall effect: Z = 2.88 (P = 0.0040)

Test for subgroup differences: Not applicable

Analysis 1.7. Comparison 1 Main comparison: Psychological intervention vs control condition, Outcome 7 Mobility: medium-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 1 Main comparison: Psychological intervention vs control condition

Outcome: 7 Mobility: medium-term

Study or subgroup	Experimental N	Control N	Hedges' g (SE)	Hedges' g IV,Random,95% CI	Weight	Hedges' g IV,Random,95% CI
Mahler 1998	190	67	0.177 (0.1741)		33.7 %	0.18 [-0.16, 0.52]
Parent 2000	36	31	0.6782 (0.2045)		31.4 %	0.68 [0.28, 1.08]
Utriyaprasit 2010	60	60	-0.1328 (0.1583)		34.9 %	-0.13 [-0.44, 0.18]
Total (95% CI)	**286**	**158**			**100.0 %**	**0.23 [-0.22, 0.67]**

Heterogeneity: $Tau^2 = 0.12$; $Chi^2 = 9.84$, df = 2 (P = 0.01); $I^2 = 80\%$

Test for overall effect: Z = 0.99 (P = 0.32)

Test for subgroup differences: Not applicable

Analysis 1.8. Comparison 1 Main comparison: Psychological intervention vs control condition, Outcome 8 Mobility: long-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 1 Main comparison: Psychological intervention vs control condition

Outcome: 8 Mobility: long-term

Study or subgroup	Experimental N	Control N	Hedges' g (SE)	Hedges' g IV,Random,95% CI	Weight	Hedges' g IV,Random,95% CI
Gilliss 1993	75	81	-0.025 (0.158)		29.8 %	-0.03 [-0.33, 0.28]
Parent 2000	36	31	0.2819 (0.2008)		20.1 %	0.28 [-0.11, 0.68]
Rief 2017	37	78	0.360134 (0.23004)		15.8 %	0.36 [-0.09, 0.81]
Utriyaprasit 2010	60	60	-0.0394 (0.1445)		34.3 %	-0.04 [-0.32, 0.24]
Total (95% CI)	**208**	**250**			**100.0 %**	**0.09 [-0.10, 0.28]**

Heterogeneity: $Tau^2 = 0.01$; $Chi^2 = 3.62$, df = 3 (P = 0.31); $I^2 = 17\%$

Test for overall effect: Z = 0.95 (P = 0.34)

Test for subgroup differences: Not applicable

Analysis 1.9. Comparison 1 Main comparison: Psychological intervention vs control condition, Outcome 9 Time to extubation: short-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 1 Main comparison: Psychological intervention vs control condition

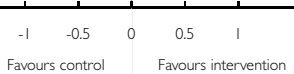
Outcome: 9 Time to extubation: short-term

Study or subgroup	Intervention N	Control N	Hedges g (SE)	Hedges g IV,Random,95% CI	Weight	Hedges g IV,Random,95% CI
Akgul 2016	22	22	0.868 (0.315)		37.4 %	0.87 [0.25, 1.49]
Deyirmenjian 2006	57	53	0.37 (0.191)		62.6 %	0.37 [0.00, 0.74]
Total (95% CI)	**79**	**75**			**100.0 %**	**0.56 [0.08, 1.03]**

Heterogeneity: $Tau^2 = 0.06$; $Chi^2 = 1.83$, df = 1 (P = 0.18); $I^2 = 45\%$

Test for overall effect: Z = 2.31 (P = 0.021)

Test for subgroup differences: Not applicable



Analysis 2.1. Comparison 2 Subgroup analysis: Psychological intervention vs standard care (TAU), Outcome 1 Pain intensity measured with continuous scales: medium-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 2 Subgroup analysis: Psychological intervention vs standard care (TAU)

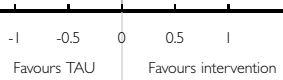
Outcome: 1 Pain intensity measured with continuous scales: medium-term

Study or subgroup	Intervention N	Control N	Hedges ' g (SE)	Hedges ' g IV,Random,95% CI	Weight	Hedges ' g IV,Random,95% CI
Guo 2012	76	77	0.1631 (0.1402)		53.1 %	0.16 [-0.11, 0.44]
Martorella 2012	30	30	0.0102 (0.2042)		25.0 %	0.01 [-0.39, 0.41]
Shelley 2007	37	43	0 (0.2182)		21.9 %	0.0 [-0.43, 0.43]
Total (95% CI)	**143**	**150**			**100.0 %**	**0.09 [-0.11, 0.29]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.59$, df = 2 (P = 0.74); $I^2 = 0.0\%$

Test for overall effect: Z = 0.87 (P = 0.38)

Test for subgroup differences: Not applicable



Analysis 2.2. Comparison 2 Subgroup analysis: Psychological intervention vs standard care (TAU), Outcome 2 Mental distress: medium-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 2 Subgroup analysis: Psychological intervention vs standard care (TAU)

Outcome: 2 Mental distress: medium-term

Study or subgroup	Intervention N	Control N	Hedges' g (SE)	Hedges' g IV,Random,95% CI	Weight	Hedges' g IV,Random,95% CI
Bergmann 2001	30	30	0.0789 (0.2237)		8.7 %	0.08 [-0.36, 0.52]
Dao 2011	48	49	1.124 (0.236)		8.4 %	1.12 [0.66, 1.59]
De Klerk 2004	25	25	1.152 (0.2451)		8.3 %	1.15 [0.67, 1.63]
Deyirmenjian 2006	57	53	0.0213 (0.1895)		9.3 %	0.02 [-0.35, 0.39]
Guo 2012	76	77	0.5525 (0.1424)		10.2 %	0.55 [0.27, 0.83]
Heilmann 2016	118	89	0.115 (0.081)		11.0 %	0.12 [-0.04, 0.27]
Mahler 1999	140	75	-0.127 (0.1694)		9.7 %	-0.13 [-0.46, 0.21]
Martorella 2012	30	30	-0.0411 (0.224)		8.7 %	-0.04 [-0.48, 0.40]
Parent 2000	36	31	1.449 (0.2971)		7.3 %	1.45 [0.87, 2.03]
Shelley 2007	37	43	0 (0.2182)		8.8 %	0.0 [-0.43, 0.43]
S rlie 2007	55	54	0.2014 (0.1664)		9.7 %	0.20 [-0.12, 0.53]
Total (95% CI)	**652**	**556**			**100.0 %**	**0.38 [0.12, 0.64]**

Heterogeneity: $Tau^2 = 0.15$; $Chi^2 = 60.90$, df = 10 (P<0.00001); $I^2 = 84\%$

Test for overall effect: Z = 2.84 (P = 0.0045)

Test for subgroup differences: Not applicable

Analysis 2.3. Comparison 2 Subgroup analysis: Psychological intervention vs standard care (TAU), Outcome 3 Mental distress: long-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 2 Subgroup analysis: Psychological intervention vs standard care (TAU)

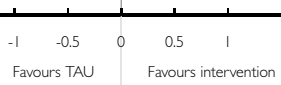
Outcome: 3 Mental distress: long-term

Study or subgroup	Intervention N	Control N	Hedges' g (SE)	Hedges' g IV,Random,95% CI	Weight	Hedges' g IV,Random,95% CI
Dao 2011	48	48	0.481 (0.145)		10.6 %	0.48 [0.20, 0.77]
De Klerk 2004	25	25	1.351 (0.2503)		8.2 %	1.35 [0.86, 1.84]
Gilliss 1993	75	81	0.25 (0.14)		10.7 %	0.25 [-0.02, 0.52]
Hoseini 2013	35	35	3.084 (0.948)		1.5 %	3.08 [1.23, 4.94]
Mahler 1999	140	75	0.18 (0.1694)		10.1 %	0.18 [-0.15, 0.51]
Moore 2001	90	90	-0.0051 (0.1414)		10.7 %	-0.01 [-0.28, 0.27]
Parent 2000	36	31	0.831 (0.2751)		7.7 %	0.83 [0.29, 1.37]
Pick 1994	25	24	0 (0.2259)		8.8 %	0.0 [-0.44, 0.44]
Rief 2017	37	0.57839091 (0.23049304)	41		8.7 %	0.58 [0.13, 1.03]
Shelley 2007	37	43	-0.1675 (0.2182)		8.9 %	-0.17 [-0.60, 0.26]
S rlie 2007	55	54	0.3875 (0.1429)		10.7 %	0.39 [0.11, 0.67]
Zarea 2014	37	37	0.666 (0.553)		3.5 %	0.67 [-0.42, 1.75]
Total (95% CI)	**640**	**584**			**100.0 %**	**0.41 [0.18, 0.65]**

Heterogeneity: $Tau^2 = 0.12$; $Chi^2 = 45.23$, df = 11 ($P<0.00001$); $I^2 = 76\%$

Test for overall effect: Z = 3.40 (P = 0.00068)

Test for subgroup differences: Not applicable



Analysis 2.4. Comparison 2 Subgroup analysis: Psychological intervention vs standard care (TAU), Outcome 4 Mobility: medium-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 2 Subgroup analysis: Psychological intervention vs standard care (TAU)

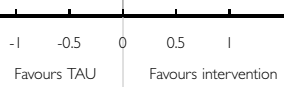
Outcome: 4 Mobility: medium-term

Study or subgroup	Intervention N	Control N	Hedges' g (SE)	Hedges' g IV,Random,95% CI	Weight	Hedges' g IV,Random,95% CI
Mahler 1998	190	67	0.177 (0.1741)		52.3 %	0.18 [-0.16, 0.52]
Parent 2000	36	31	0.6782 (0.2045)		47.7 %	0.68 [0.28, 1.08]
Total (95% CI)	**226**	**98**			**100.0 %**	**0.42 [-0.07, 0.91]**

Heterogeneity: $Tau^2 = 0.09$; $Chi^2 = 3.48$, df = 1 (P = 0.06); $I^2 = 71\%$

Test for overall effect: Z = 1.66 (P = 0.096)

Test for subgroup differences: Not applicable



Analysis 2.5. Comparison 2 Subgroup analysis: Psychological intervention vs standard care (TAU), Outcome 5 Mobility: long-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 2 Subgroup analysis: Psychological intervention vs standard care (TAU)

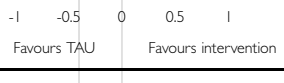
Outcome: 5 Mobility: long-term

Study or subgroup	Intervention N	Control N	Hedges' g (SE)	Hedges' g IV,Random,95% CI	Weight	Hedges' g IV,Random,95% CI
Gilliss 1993	75	81	-0.025 (0.158)		38.2 %	-0.03 [-0.33, 0.28]
Parent 2000	36	31	0.2819 (0.2008)		32.6 %	0.28 [-0.11, 0.68]
Rief 2017	37	0.61546962 (0.22985293)	41		29.2 %	0.62 [0.16, 1.07]
Total (95% CI)	**148**	**153**			**100.0 %**	**0.26 [-0.10, 0.63]**

Heterogeneity: $Tau^2 = 0.07$; $Chi^2 = 5.45$, df = 2 (P = 0.07); $I^2 = 63\%$

Test for overall effect: Z = 1.41 (P = 0.16)

Test for subgroup differences: Not applicable



Analysis 3.1. Comparison 3 Subgroup analysis: Psychological intervention vs attention control group, Outcome 1 Mental distress: medium-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 3 Subgroup analysis: Psychological intervention vs attention control group

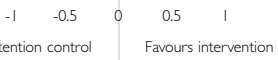
Outcome: 1 Mental distress: medium-term

Study or subgroup	Intervention N	Control N	Hedges' g (SE)	Hedges' g IV,Random,95% CI	Weight	Hedges' g IV,Random,95% CI
Ku 2002	30	30	0.8024 (0.2652)		47.6 %	0.80 [0.28, 1.32]
Utriyaprasit 2010	60	60	-0.0859 (0.1815)		52.4 %	-0.09 [-0.44, 0.27]
Total (95% CI)	**90**	**90**			**100.0 %**	**0.34 [-0.53, 1.21]**

Heterogeneity: $Tau^2 = 0.34$; $Chi^2 = 7.64$, df = 1 (P = 0.01); $I^2 = 87\%$

Test for overall effect: Z = 0.76 (P = 0.45)

Test for subgroup differences: Not applicable



Analysis 3.2. Comparison 3 Subgroup analysis: Psychological intervention vs attention control group, Outcome 2 Mental distress: long-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 3 Subgroup analysis: Psychological intervention vs attention control group

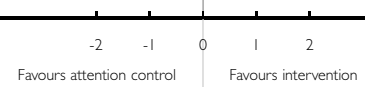
Outcome: 2 Mental distress: long-term

Study or subgroup	Intervention N	Control N	Hedges' g (SE)	Hedges' g IV,Random,95% CI	Weight	Hedges' g IV,Random,95% CI
Pick 1994	25	25	0 (0.2236)		18.2 %	0.0 [-0.44, 0.44]
Rief 2017	37	0.30150308 (0.23289834)	37		17.2 %	0.30 [-0.15, 0.76]
Utriyaprasit 2010	60	60	-0.2672 (0.1587)		28.2 %	-0.27 [-0.58, 0.04]
Zarani 2010	90	90	0.0851 (0.1218)		36.5 %	0.09 [-0.15, 0.32]
Total (95% CI)	**212**	**212**			**100.0 %**	**0.01 [-0.21, 0.23]**

Heterogeneity: $Tau^2 = 0.02$; $Chi^2 = 5.00$, df = 3 (P = 0.17); $I^2 = 40\%$

Test for overall effect: Z = 0.07 (P = 0.95)

Test for subgroup differences: Not applicable



Analysis 3.3. Comparison 3 Subgroup analysis: Psychological intervention vs attention control group, Outcome 3 Mobility: long-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 3 Subgroup analysis: Psychological intervention vs attention control group

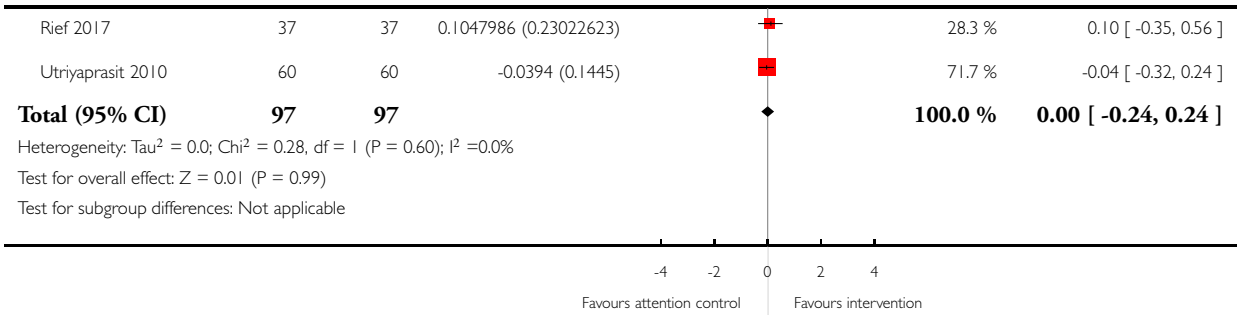
Outcome: 3 Mobility: long-term

Study or subgroup	Intervention N	Control N	Hedges g (SE)	Hedges g IV,Random,95% CI	Weight	Hedges g IV,Random,95% CI
Rief 2017	37	37	0.1047986 (0.23022623)		28.3 %	0.10 [-0.35, 0.56]
Utriyaprasit 2010	60	60	-0.0394 (0.1445)		71.7 %	-0.04 [-0.32, 0.24]
Total (95% CI)	**97**	**97**			**100.0 %**	**0.00 [-0.24, 0.24]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.28$, df = 1 (P = 0.60); $I^2 = 0.0\%$

Test for overall effect: Z = 0.01 (P = 0.99)

Test for subgroup differences: Not applicable



Analysis 4.1. Comparison 4 Subgroup analysis: Psychoeducation vs control condition, Outcome 1 Mental distress: medium-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 4 Subgroup analysis: Psychoeducation vs control condition

Outcome: 1 Mental distress: medium-term

Study or subgroup	Intervention N	Control N	Hedges' g (SE)	Hedges' g IV,Random,95% CI	Weight	Hedges' g IV,Random,95% CI
Bergmann 2001	30	30	0.0789 (0.2237)		14.1 %	0.08 [-0.36, 0.52]
Deyirmenjian 2006	57	53	0.0213 (0.1895)		15.0 %	0.02 [-0.35, 0.39]
Guo 2012	76	77	0.5525 (0.1424)		16.1 %	0.55 [0.27, 0.83]
Ku 2002	30	30	0.8024 (0.2652)		13.0 %	0.80 [0.28, 1.32]
Mahler 1999	140	75	-0.127 (0.1694)		15.5 %	-0.13 [-0.46, 0.21]
Martorella 2012	30	30	-0.0411 (0.224)		14.1 %	-0.04 [-0.48, 0.40]
Parent 2000	36	31	1.4489 (0.2971)		12.2 %	1.45 [0.87, 2.03]
Total (95% CI)	**399**	**326**			**100.0 %**	**0.36 [0.00, 0.72]**

Heterogeneity: $Tau^2 = 0.19$; $Chi^2 = 33.49$, df = 6 (P<0.00001); $I^2 = 82\%$

Test for overall effect: Z = 1.96 (P = 0.051)

Test for subgroup differences: Not applicable

Analysis 4.2. Comparison 4 Subgroup analysis: Psychoeducation vs control condition, Outcome 2 Mental distress: long-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 4 Subgroup analysis: Psychoeducation vs control condition

Outcome: 2 Mental distress: long-term

Study or subgroup	Intervention N	Control N	Hedges' g (SE)	Hedges' g IV,Random,95% CI	Weight	Hedges' g IV,Random,95% CI
Hoseini 2013	35	35	3.084 (0.948)		6.0 %	3.08 [1.23, 4.94]
Mahler 1999	140	75	0.18 (0.1694)		28.2 %	0.18 [-0.15, 0.51]
Moore 2001	90	90	-0.0051 (0.1414)		29.3 %	-0.01 [-0.28, 0.27]
Parent 2000	36	31	0.831 (0.2751)		23.5 %	0.83 [0.29, 1.37]
Zarea 2014	37	37	0.666 (0.553)		13.0 %	0.67 [-0.42, 1.75]
Total (95% CI)	**338**	**268**			**100.0 %**	**0.52 [0.01, 1.02]**

Heterogeneity: $Tau^2 = 0.21$; $Chi^2 = 17.30$, df = 4 (P = 0.002); $I^2 = 77\%$

Test for overall effect: Z = 2.00 (P = 0.045)

Test for subgroup differences: Not applicable

Analysis 5.1. Comparison 5 Subgroup analysis: Relaxation vs control condition, Outcome 1 Mental distress: long-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 5 Subgroup analysis: Relaxation vs control condition

Outcome: 1 Mental distress: long-term

Study or subgroup	Intervention N	Control N	Hedges' g (SE)	Hedges' g IV,Random,95% CI	Weight	Hedges' g IV,Random,95% CI
De Klerk 2004	25	25	1.351 (0.2503)		49.7 %	1.35 [0.86, 1.84]
Pick 1994	25	49	0 (0.2259)		50.3 %	0.0 [-0.44, 0.44]
Total (95% CI)	**50**	**74**			**100.0 %**	**0.67 [-0.65, 2.00]**

Heterogeneity: $Tau^2 = 0.86$; $Chi^2 = 16.06$, df = 1 (P = 0.00006); $I^2 = 94\%$

Test for overall effect: Z = 0.99 (P = 0.32)

Test for subgroup differences: Not applicable

Analysis 6.1. Comparison 6 Subgroup analysis: Combined intervention vs control condition, Outcome 1 Mental distress: medium-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 6 Subgroup analysis: Combined intervention vs control condition

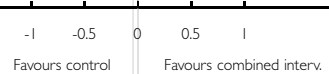
Outcome: 1 Mental distress: medium-term

Study or subgroup	Intervention N	Control N	Hedges' g (SE)	Hedges' g IV,Random,95% CI	Weight	Hedges' g IV,Random,95% CI
Dao 2011	48	49	1.124 (0.236)		16.9 %	1.12 [0.66, 1.59]
Heilmann 2016	118	89	0.115 (0.081)		24.8 %	0.12 [-0.04, 0.27]
Shelley 2007	37	43	0 (0.2182)		17.8 %	0.0 [-0.43, 0.43]
S rlie 2007	55	54	0.2014 (0.1664)		20.6 %	0.20 [-0.12, 0.53]
Utriyaprasit 2010	60	60	-0.0859 (0.1815)		19.8 %	-0.09 [-0.44, 0.27]
Total (95% CI)	**318**	**295**			**100.0 %**	**0.24 [-0.07, 0.56]**

Heterogeneity: $Tau^2 = 0.10$; $Chi^2 = 19.42$, df = 4 (P = 0.00065); $I^2 = 79\%$

Test for overall effect: Z = 1.50 (P = 0.13)

Test for subgroup differences: Not applicable



Analysis 6.2. Comparison 6 Subgroup analysis: Combined intervention vs control condition, Outcome 2 Mental distress: long-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 6 Subgroup analysis: Combined intervention vs control condition

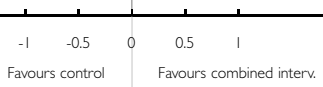
Outcome: 2 Mental distress: long-term

Study or subgroup	Intervention N	Control N	Hedges g (SE)	Hedges g IV,Random,95% CI	Weight	Hedges g IV,Random,95% CI
Dao 2011	48	0	0.481 (0.145)		17.2 %	0.48 [0.20, 0.77]
Gilliss 1993	75	81	0.25 (0.14)		17.5 %	0.25 [-0.02, 0.52]
Shelley 2007	37	43	-0.1675 (0.2182)		12.8 %	-0.17 [-0.60, 0.26]
S rlie 2007	55	54	0.3875 (0.1429)		17.4 %	0.39 [0.11, 0.67]
Utriyaprasit 2010	60	60	-0.2672 (0.1587)		16.3 %	-0.27 [-0.58, 0.04]
Zarani 2010	90	90	0.0851 (0.1218)		18.7 %	0.09 [-0.15, 0.32]
Total (95% CI)	**365**	**328**			**100.0 %**	**0.14 [-0.08, 0.37]**

Heterogeneity: $Tau^2 = 0.06$; $Chi^2 = 17.71$, df = 5 (P = 0.003); $I^2 = 72\%$

Test for overall effect: Z = 1.25 (P = 0.21)

Test for subgroup differences: Not applicable



Analysis 7.1. Comparison 7 Sensitivity analysis: Studies with adequate sequence generation, Outcome 1 Mental distress: medium-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 7 Sensitivity analysis: Studies with adequate sequence generation

Outcome: 1 Mental distress: medium-term

Study or subgroup	Intervention N	Control N	Hedges' g (SE)	Hedges' g IV,Random,95% CI	Weight	Hedges' g IV,Random,95% CI
Dao 2011	48	49	1.124 (0.236)		15.6 %	1.12 [0.66, 1.59]
Guo 2012	76	77	0.5525 (0.1424)		18.1 %	0.55 [0.27, 0.83]
Heilmann 2016	118	89	0.115 (0.081)		19.3 %	0.12 [-0.04, 0.27]
Martorella 2012	30	30	-0.0411 (0.224)		16.0 %	-0.04 [-0.48, 0.40]
Parent 2000	36	31	1.4489 (0.2971)		13.9 %	1.45 [0.87, 2.03]
Utriyaprasit 2010	60	60	-0.0859 (0.1815)		17.1 %	-0.09 [-0.44, 0.27]
Total (95% CI)	**368**	**336**			**100.0 %**	**0.48 [0.08, 0.87]**

Heterogeneity: $Tau^2 = 0.20$; $Chi^2 = 42.20$, df = 5 ($P<0.00001$); $I^2 = 88\%$

Test for overall effect: Z = 2.38 (P = 0.017)

Test for subgroup differences: Not applicable

Analysis 7.2. Comparison 7 Sensitivity analysis: Studies with adequate sequence generation, Outcome 2 Mental distress: long-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 7 Sensitivity analysis: Studies with adequate sequence generation

Outcome: 2 Mental distress: long-term

Study or subgroup	Intervention N	Control N	Hedges' g (SE)	Hedges' g IV,Random,95% CI	Weight	Hedges' g IV,Random,95% CI
Dao 2011	48	48	0.481 (0.145)		17.6 %	0.48 [0.20, 0.77]
Gilliss 1993	75	81	0.25 (0.14)		17.8 %	0.25 [-0.02, 0.52]
Moore 2001	90	90	-0.0051 (0.1414)		17.7 %	-0.01 [-0.28, 0.27]
Parent 2000	36	31	0.831 (0.2751)		11.7 %	0.83 [0.29, 1.37]
Rief 2017	37	78	0.439947 (0.2316)		13.5 %	0.44 [-0.01, 0.89]
Utriyaprasit 2010	60	60	-0.2672 (0.1587)		16.9 %	-0.27 [-0.58, 0.04]
Zarea 2014	37	0	0.666 (0.553)		4.8 %	0.67 [-0.42, 1.75]
Total (95% CI)	**383**	**388**			**100.0 %**	**0.27 [0.00, 0.54]**

Heterogeneity: $Tau^2 = 0.09$; $Chi^2 = 21.69$, df = 6 (P = 0.001); $I^2 = 72\%$

Test for overall effect: Z = 1.97 (P = 0.049)

Test for subgroup differences: Not applicable

Analysis 8.1. Comparison 8 Sensitivity analysis: Studies with adequate handling of incomplete outcome data, Outcome 1 Mental distress: medium-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 8 Sensitivity analysis: Studies with adequate handling of incomplete outcome data

Outcome: 1 Mental distress: medium-term

Study or subgroup	Intervention N	Control N	Hedges' g (SE)	Hedges' g IV,Random,95% CI	Weight	Hedges' g IV,Random,95% CI
Bergmann 2001	30	30	0.0789 (0.2237)		10.8 %	0.08 [-0.36, 0.52]
Dao 2011	48	49	1.124 (0.236)		10.3 %	1.12 [0.66, 1.59]
Deyirmenjian 2006	57	53	0.0213 (0.1895)		12.1 %	0.02 [-0.35, 0.39]
Guo 2012	76	77	0.5525 (0.1424)		14.1 %	0.55 [0.27, 0.83]
Heilmann 2016	118	89	0.115 (0.081)		16.5 %	0.12 [-0.04, 0.27]
Martorella 2012	30	30	-0.0411 (0.224)		10.7 %	-0.04 [-0.48, 0.40]
S rlie 2007	55	54	0.2014 (0.1664)		13.1 %	0.20 [-0.12, 0.53]
Utriyaprasit 2010	60	60	-0.0859 (0.1815)		12.5 %	-0.09 [-0.44, 0.27]
Total (95% CI)	**474**	**442**			**100.0 %**	**0.23 [0.01, 0.46]**

Heterogeneity: $Tau^2 = 0.08$; $Chi^2 = 27.38$, df = 7 (P = 0.00028); $I^2 = 74\%$

Test for overall effect: Z = 2.02 (P = 0.043)

Test for subgroup differences: Not applicable

Analysis 8.2. Comparison 8 Sensitivity analysis: Studies with adequate handling of incomplete outcome data, Outcome 2 Mental distress: long-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 8 Sensitivity analysis: Studies with adequate handling of incomplete outcome data

Outcome: 2 Mental distress: long-term

Study or subgroup	Intervention N	Control N	Hedges' g (SE)	Hedges' g IV,Random,95% CI	Weight	Hedges' g IV,Random,95% CI
Dao 2011	48	48	0.481 (0.145)		16.2 %	0.48 [0.20, 0.77]
Gilliss 1993	75	81	0.25 (0.14)		16.4 %	0.25 [-0.02, 0.52]
Hoseini 2013	35	35	3.084 (0.948)		1.9 %	3.08 [1.23, 4.94]
Moore 2001	90	90	-0.0051 (0.1414)		16.3 %	-0.01 [-0.28, 0.27]
Rief 2017	37	78	0.439947 (0.2316)		12.6 %	0.44 [-0.01, 0.89]
S rlie 2007	55	54	0.3875 (0.1429)		16.3 %	0.39 [0.11, 0.67]
Utriyaprasit 2010	60	60	-0.2672 (0.1587)		15.6 %	-0.27 [-0.58, 0.04]
Zarea 2014	37	37	0.666 (0.553)		4.7 %	0.67 [-0.42, 1.75]
Total (95% CI)	**437**	**483**			**100.0 %**	**0.28 [0.02, 0.55]**

Heterogeneity: $Tau^2 = 0.09$; $Chi^2 = 27.30$, df = 7 (P = 0.00029); $I^2 = 74\%$

Test for overall effect: Z = 2.08 (P = 0.038)

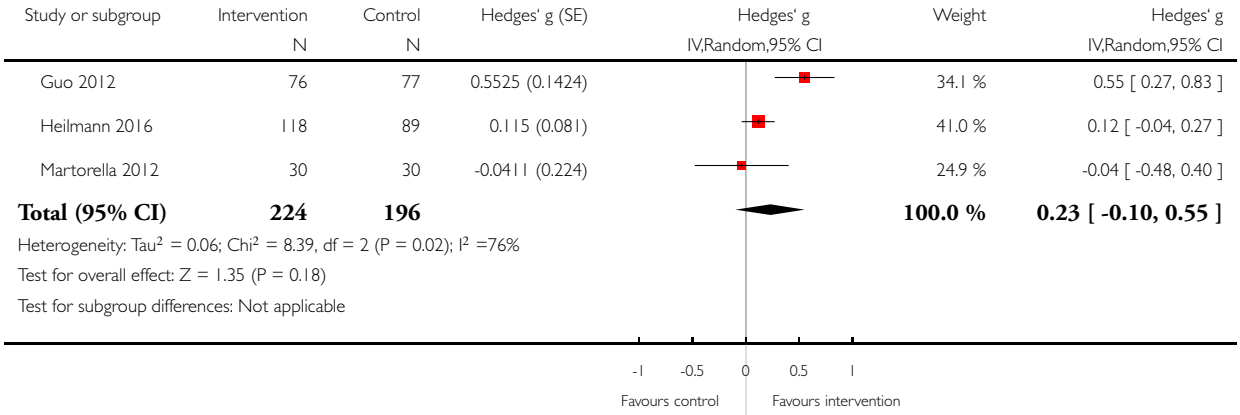
Test for subgroup differences: Not applicable

Analysis 9.1. Comparison 9 Sensitivity analysis: Studies with study protocol available, Outcome 1 Mental distress: medium-term.

Review: Psychological interventions for acute pain after open heart surgery

Comparison: 9 Sensitivity analysis: Studies with study protocol available

Outcome: 1 Mental distress: medium-term



ADDITIONAL TABLES

Table 1. Postoperative complications

Martorella 2012	Deyirmenjian 2006	Parent 2000	Heilmann 2016	Rief 2017
Postoperative complications (not specified) Intervention: n = 13 (45%) Control: n = 15 (68%)	Pulmonary complications Intervention: n = 0 Control: n = 1 (1.8%) Thrombosis Intervention: n = 0 Control: n = 0 Psychosis Intervention: n = 2 (3.8%) Control: n = 1 (1.8%) Other complications Intervention: n = 7 (13.2%) Control: n = 8 (14%)	Postoperative complications Intervention: 11% (pulmonary oedema, peripheral embolism, intestinal reocclusion) Control: 6.5% (pulmonary oedema)	Inaccessibility of the participant due to medical reasons Intervention: n = 10 Control: n = 13	Participants with adverse events after CABG Intervention: n = 9 (28.13%) Control: n = 13 (38.24%) Attention Control: n = 10 (33.33%)

n = number of participants with adverse events (postoperative complications)

APPENDICES

Appendix 1. MEDLINE search strategy

1 exp Pain/
2 Pain, Postoperative/
3 pain*.mp.
4 1 or 2 or 3
5 exp Cardiac Surgical Procedures/
6 Sternotomy/ or sternotomy.mp.
7 Thoracotomy/ or thoracotomy.mp.
8 Cardiopulmonary Bypass/
9 (CABS or CABG).mp.
10 ((heart* or coronary or cardio* or cardiac or valve* or congenital lesion* or thoracic aorta) adj5 (surg* or intervention* or procedure* or bypass*)).mp.
11 5 or 6 or 7 or 8 or 9 or 10
12 Patient Education as Topic/
13 (inform* or educat* or psychoeducat* or knowledge* or instruct* or communicat*).mp.
14 exp Psychotherapy/
15 exp Mind-Body Therapies/
16 (psychotherap* or psychologic* or behaviour* or behavior* or cognit*).mp.
17 (problem adj5 solv*).mp.
18 (relax* or breath*).mp.
19 (hypno* or self-hypno* or auto-hypno* or suggest* or (autogenic adj5 train*)).mp.
20 (imag* or attention* or distract* or visuali* or refram* or reapprais*).mp.
21 Emotions/ or emotion*.mp.
22 (cope or coping or counsel*).mp.
23 ((stress* or anxiety or anxious*) adj5 (manag* or therap* or treat*)).mp.
24 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23
25 4 and 11 and 24
26 randomized controlled trial.pt.
27 controlled clinical trial.pt.
28 randomized.ab.
29 placebo.ab.
30 clinical trials as topic.sh.
31 randomly.ab.
32 trial.ti.
33 26 or 27 or 28 or 29 or 30 or 31 or 32
34 25 and 33
key:
mp = protocol supplementary concept, rare disease supplementary concept, title, original title, abstract, name of substance word, subject heading word, unique identifier
pt = publication type
ab = abstract

sh = subject heading
it = title

Appendix 2. CENTRAL search strategy

1 pain*:TI,AB,KY
2 MESH DESCRIPTOR pain
3 MESH DESCRIPTOR acute pain
4 MESH DESCRIPTOR Pain, Postoperative
5 1 OR 2 OR 3 OR 4
6 MESH DESCRIPTOR Cardiac Surgical Procedures EXPLODE ALL TREES
7 MESH DESCRIPTOR Sternotomy EXPLODE ALL TREES
8 sternotomy:TI,AB,KY
9 MESH DESCRIPTOR Thoracotomy EXPLODE ALL TREES
10 thoracotomy:TI,AB,KY
11 MESH DESCRIPTOR Cardiopulmonary Bypass EXPLODE ALL TREES
12 (CABS or CABG):TI,AB,KY
13 ((heart* or coronary or cardio* or cardiac or valve* or congenital lesion* or thoracic aorta) near5 (surg* or intervention* or procedure* or bypass*)):TI,AB,KY
14 6 OR 7 OR 8 OR 9 OR 10 OR 11 OR 12 OR 13
15 MESH DESCRIPTOR Patient Education as Topic
16 (inform* or educat* or psychoeducat* or knowledge* or instruct* or communicat*):TI,AB,KY
17 MESH DESCRIPTOR Psychotherapy EXPLODE ALL TREES
18 MESH DESCRIPTOR Mind-Body Therapies EXPLODE ALL TREES
19 (psychotherap* or psychologic* or behaviour* or behavior* or cognit*):TI,AB,KY
20 (problem near5 solv*):TI,AB,KY
21 (relax* or breath*):TI,AB,KY
22 (hypno* or self-hypno*):TI,AB,KY
23 (imag* or attention* or distract* or visuali* or refram* or reapprais*):TI,AB,KY
24 MESH DESCRIPTOR Emotions EXPLODE ALL TREES
25 emotion*:TI,AB,KY
26 (cope or coping or counsel*):TI,AB,KY
27 ((stress* or anxiety or anxious*) near5 (manag* or therap* or treat*)):TI,AB,KY
28 15 OR 16 OR 17 OR 18 OR 19 OR 20 OR 21 OR 22 OR 23 OR 24 OR 25 OR 26 OR 27
29 5 AND 14 AND 28
30 31/10/2013 TO 29/02/2016:DL
31 29 AND 30

Appendix 3. Embase search strategy

1 exp pain/
2 pain*.mp.
3 1 or 2
4 exp heart surgery/
5 sternotomy/ or sternotomy.mp.
6 thoracotomy/ or thoracotomy.mp.
7 cardiopulmonary bypass/
8 (CABS or CABG).mp.
9 ((heart* or coronary or cardio* or cardiac or valve* or congenital lesion* or thoracic aorta) adj5 (surg* or intervention* or procedure* or bypass*)).mp.
10 4 or 5 or 6 or 7 or 8 or 9
11 patient education/

12 (inform* or educat* or psychoeducat* or knowledge* or instruct* or communicat*).mp.
13 exp psychotherapy/
14 hypnosis/
15 (psycotherap* or psychologic* or behaviour* or behavior* or cognit*).mp.
16 (problem* adj5 solv*).mp.
17 (relax* or breath*).mp.
18 (hypno* or self-hypno* or auto-hypno* or suggest* or (autogenic adj5 train*)).mp.
19 (imag* or attention* or distract* or visuali* or refram* or reapprais*).mp.
20 exp emotion/ or emotion*.mp.
21 (cope or coping or counsel*).mp.
22 ((stress* or anxiety or anxious*) adj5 (manag* or therap* or treat*)).mp.
23 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22
24 3 and 10 and 23
25 crossover procedure/
26 double-blind procedure/
27 randomized controlled trial/
28 single-blind procedure/
29 random*.mp.
30 factorial*.mp.
31 (crossover* or cross over* or cross-over*).mp.
32 placebo*.mp.
33 (double* adj blind*).mp.
34 (singl* adj blind*).mp.
35 assign*.mp.
36 allocat*.mp.
37 volunteer*.mp.
38 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37
39 24 and 38
key:
[mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]

Appendix 4. PsycINFO (OVID) search strategy

1. exp Pain/
2. pain*.mp.
3. 1 or 2
4. exp Heart Surgery/
5. Sternotomy/ or sternotomy.mp.
6. Thoracotomy/ or thoracotomy.mp.
7. (CABS or CABG).mp.
8. ((heart* or coronary or cardio* or cardiac or valve* or congenital lesion* or thoracic aorta) adj5 (surg* or intervention* or procedure* or bypass*)).mp.
9. 4 or 5 or 6 or 7 or 8
10. Client Education/
11. (inform* or educat* or psychoeducat* or knowledge* or instruct* or communicat*).mp.
12. exp Psychotherapy/
13. exp Mind Body Therapy/
14. (psychotherap* or psychologic* or behaviour* or behavior* or cognit*).mp.
15. (problem adj5 solv*).mp.
16. (relax* or breath*).mp.
17. (hypno* or self-hypno* or auto-hypno* or suggest* or (autogenic adj5 train*)).mp.

18. (imag* or attention* or distract* or visuali* or reframe* or reapprais*).mp.
19. Emotions/ or emotion*.mp.
20. (cope or coping or counsel*).mp.
21. ((stress* or anxiety or anxious*) adj5 (manag* or therap* or treat*)).mp.
22. or/10-21
23. 3 and 9 and 22
24. clinical trials/
25. (randomis* or randomiz*).tw.
26. (random$ adj3 (allocat$ or assign$)).tw.
27. ((clinic$ or control$) adj trial$).tw.
28. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (blind$ or mask$)).tw.
29. (crossover$ or "cross over$").tw.
30. random sampling/
31. Experiment Controls/
32. Placebo/
33. placebo$.tw.
34. exp program evaluation/
35. treatment effectiveness evaluation/
36. ((effectiveness or evaluat$) adj3 (stud$ or research$)).tw.
37. or/24-36

Appendix 5. Web of Science (ISI) search strategy

#14 #13 AND #4 AND #1
#13 #12 OR #11 OR #10 OR #9 OR #8 OR #7 OR #6 OR #5
#12 Topic=(((stress* or anxiety or anxious*) n/5 (manag* or therap* or treat*)))
#11 Topic=(emotion* or cope or coping or counsel*)
#10 Topic=((imag* or attention* or distract* or visuali* or reframe* or reapprais*))
#9 Topic=((hypno* or self-hypno* or auto-hypno* or suggest* or (autogenic n/5 train*)))
#8 Topic=((relax* or breath*))
#7 Topic=((problem N/5 solv*))
#6 Topic=((psychotherap* or psychologic* or behaviour* or behavior* or cognit*))
#5 Topic=((inform* or educat* or psychoeducat* or knowledge* or instruct* or communicat*))
#4 #3 OR #2
#3 Topic=(((heart* or coronary or cardio* or cardiac or valve* or congenital lesion* or thoracic aorta) N/5 (surg* or intervention* or procedure* or bypass*)))
#2 Topic=(sternotomy or thoracotomy or CABS or CABG)
#1 Topic=(pain*)

WHAT'S NEW

Last assessed as up-to-date: 1 February 2017.

Date	Event	Description
13 July 2017	Amended	Contact details updated.

HISTORY

Protocol first published: Issue 7, 2012

Review first published: Issue 5, 2014

Date	Event	Description
21 February 2017	New citation required but conclusions have not changed	We have added six new studies but the conclusions remain unchanged
1 February 2017	New search has been performed	We updated this review to include the results of a new search on 1st February 2017

CONTRIBUTIONS OF AUTHORS

SZ: Developed a search strategy, searched for studies, selected which studies to include, extracted data from studies, entered data into RevMan 2014, carried out the analyses, interpreted the analyses, drafted the final write-up of the review and update.

JR: Drafted protocol, offered methodological and statistical advice.

JB: Offered methodological and statistical advice.

BS: Offered methodological and statistical advice.

AM: Offered methodological and statistical advice.

SK: Drafted protocol, selected which studies to include, extracted data from studies.

DECLARATIONS OF INTEREST

SZ: none known.

JR: none known; JR is a specialist in psychotherapy.

JB: none known; JB is a specialist in psychotherapy.

BS: none known; BS is a specialist in psychotherapy.

AM: none known; AM is a specialist in psychotherapy and psycho-oncology.

SK: none known; SK is a specialist in psychotherapy and psycho-oncology.

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DIFFERENCES BETWEEN PROTOCOL AND REVIEW

We added GRADE methods wording to the Data synthesis section.

INDEX TERMS

Medical Subject Headings (MeSH)

Acute Pain [psychology; *therapy]; Analgesics [therapeutic use]; Behavior Therapy [*methods]; Cardiac Surgical Procedures [*adverse effects]; Cognitive Therapy; Pain Measurement; Pain, Postoperative [psychology; *therapy]; Randomized Controlled Trials as Topic; Relaxation Therapy [*methods]; Stress, Psychological [epidemiology]

MeSH check words

Adult; Aged; Female; Humans; Male; Middle Aged